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CYCLE BUILDING AND REPAIRING

WITH NUMEROUS ENGRAVINGS AND DIAGRAMS

EDITED BY

PAUL N. ooncree HASLUCK

EDITOR OF "WORK,"
AUTHOR OF "HANDYBOOKS FOR HANDYCRAFTS," ETC. ETC.

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PREFACE.

THIS Handbook contains, in a form convenient for everyday use, a comprehensive digest of the information on Cycle Building and Repairing, scattered over ten thousand columns of WORK, the weekly journal it is my fortune to edit—and supplies concise instruction on the general principles of the subjects on which it treats.

In preparing for publication in book form the mass of relevant matter contained in the volumes of WORK, much that was tautological in character had to be rejected. The remainder necessarily had to be arranged anew, altered and largely re-written. From these causes the contributions of many are so blended that the writings of individuals cannot be distinguished for acknowledgment.

Readers who may desire additional information respecting special details of the matters dealt with in this Handbook, or instruction on kindred subjects, should address a question to WORK, so that it may be answered in the columns of that journal.

P. N. HASLUCK.

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CYCLE BUILDING AND REPAIRING.

CHAPTER 1.

INTRODUCTORY, AND TOOLS USED.

The word cycle—a circle—is used to denote a wheel; thus: bicycle, two wheels; tricycle, three wheels: quadricycle, four wheels; and so on. Adaptability, however, has caused it to become recognised as a general term for all. For years the "Ordinary," with its high front wheel, was the popular machine; then makers sought to introduce a safer one, such as the "Facile," "Xtraordinary," "Sun and Planet," and others, including several types of the "Kangaroo"

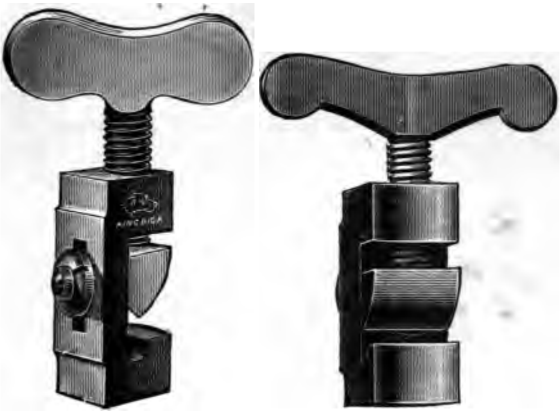


Fig. 1. Fig. 2.
Spoke Grips.

pattern. These now give place to the present st known as the rear-driven "Safety," to the construct and repairing of which this Handbook is speci directed.

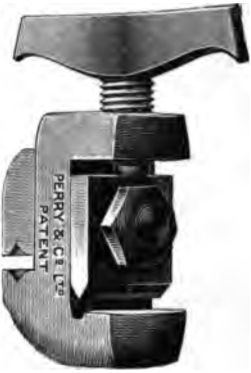


Fig. 3.—Combined Spoke Grip and Nipple Key.

Before commencing cycle building and repairing so mention must be made of the tools required.

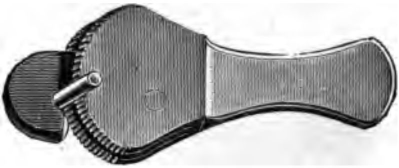


Fig. 4.—Automatic Spoke Grip.

A lathe stands foremost as a necessary tool; should be not less than 4½ centre. A back-geared scr cutting lathe with slide-rest being the most suita kind. An ordinary back-geared lathe with a sli rest may be used; the slow speed is for turning ir and the quick speed for brass and wood. The sl speed is also used for drilling large, and the quick small holes. A couple of chucks are required the lathe—one with four, another with two independent jaws—to hold small pieces, such as pins, and to hold the twist drills with shanks ¾ in. thick, or of any less size. A Cushman two-jaw chuck fitted to the lathe mandrel will take in objects from about 2 in. down to ¼ in., and is effective for holding the larger-sized drills. For drills under ¼-in. shank another chuck is required. Various kinds of lathes and chucks are illustrated and described in "The Metal Turner's Handy Book," a shilling manual written by the editor of this present Handbook.

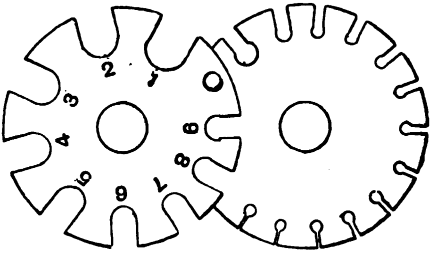


Fig. 5.—Gauge for measuring Wire.

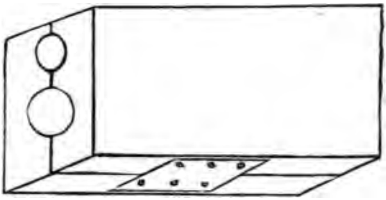


Fig. 6.—Wood Jaws for holding Tubes.

A ratchet brace is necessary for boring out broken spoke stumps and for many other purposes. One with a small three-jaw chuck that holds drills with shanks $\frac{3}{16}$ in. thick, or of any less size, will answer the purpose. Twist drills are generally used in the lathe for boring holes from ¾ in. downwards.

A forge is necessary for all kinds of light forgings, for tempering tools, heating tyres, cementing rubbers, etc. For brazing, a forge with a fan blower or continuous blast bellows will be required. A fan blower fitted to a small forge does very well for brazing.

A small anvil fixed to a bench, or a smith's anvil fixed on a block of some kind, can hardly be dispensed with, although some people use a common flat-iron for knocking out drills, etc.

The vices required include a strong leg-vice attached to a substantial bench, bolted through the wall for firmness and secured by the leg to the ground or to one of the bench supports, a good bench-vice, with 3-in. or 3½-in. parallel jaws, and one or two hand-vices of different sizes

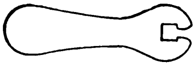


Fig. 7.

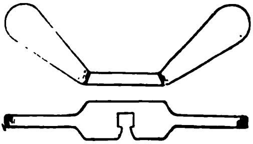


Fig. 8.

Nipple Keys.

A grindstone, not less than 14 in. or 15 in. in diameter, mounted in a metal trough, is a most useful tool, but a smaller one might serve for grinding drills and slide rest tools, etc.

A reliable spoke grip is one of the most necessary tools; the King Dick (Fig. 1), is of the Abingdon Works make. Fig. 2 is a similar tool made by Wynn, Timmins & Co., Ltd., and Fig. 3 is Perry's combined spoke grip and nipple key. Another kind (Fig. 4), brought out by Wynn, Timmins and Co., Ltd., is an improvement, as its grip is instantaneous, and therefore dispenses with the operations of screwing and unscrewing every time it is applied to a spoke. Spoke grips of the commoner sort are of no use for constant shop work, being made of malleable iron, case hardened ; and when it is considered that the face of the sliding block should be a knife edge, it will readily be understood that iron is quite unsuitable, and that steel is necessary for the purpose.

The owner of a screw-cutting lathe can, of course, dispense with stocks and dies, as screwing can be done in the lathe. In the absence of this machine, a small set of Whitworth dies and taps will be required screwing from $\frac{3}{16}$ in. to $\frac{3}{8}$ in., also $\frac{5}{8}$ in. and 1 in. fine-thread. These will screw everything required except spokes.

Spoke screwing tackle is more likely to match the screw the hubs are tapped with when bought with the hubs already finished, tapped, and plated. Two single-hole screw-plates, or a small screw-plate with a range of sizes from about 15 S.W.G. to 11 S.W.G., serve most purposes for spoke-screwing. For nipple-screwing a small die stock could be used with five pairs of dies from $\frac{1}{8}$ in., rising by $\frac{1}{32}$ in. to $\frac{1}{4}$ in. Nipple keys of the forms represented by Figs. 7 and 8 may be made without much difficulty.

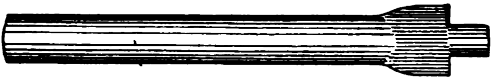


Fig. 9.—Pin Drill for facing Lugs, etc.

A wire gauge shown at Fig. 5 is very handy, and almost necessary, and no cycle repairer should be without one. It is called the Birmingham wire gauge, and is handy for sizing wire, drills, pins, and for other purposes. Stubbs' letter gauge is also used for sizing twist drills, etc., but being costly, it may be dispensed with.

A wire scratch brush is used for brushing the brazed joint immediately it is taken from the fire, removing scale, borax, and superfluous brass, making it much easier and quicker to file up, and saving wear of files.

A polishing lathe is a tool for bobbing and polishing up the parts after they have been roughly filed; it effects a great saving over hand-polishing.

The files required comprise 12-in. flat, 10-in. and 6-in. rounds, 8-in. half-round, 10-in. flat and 8-in. half-round smooths.

A necessary tool to hold the various tubes in the vice whilst filing, fitting, etc., is shown at Fig. 6.

It consists of a block of hard wood about 4 in. long and 2½ in. square, having a hole bored through its length of the diameter of the tube it is to hold. The block is then sawn through the centre of the hole lengthways, and a piece of leather is screwed on as a hinge. This makes a pair of jaws which will hold the thinnest of tubes firmly, without damaging them. Holes of two sizes may be drilled in each pair of jaws. A separate hole is required for each size of tube used, one pair of jaws having a 1-in. hole, and another pair with ¾-in. and ½-in. holes will answer every purpose for the machines usually dealt with.

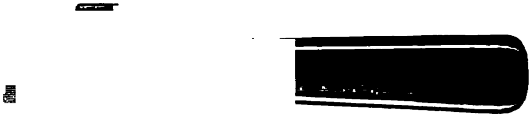


Fig. 10.—Adjustable Spanner.

Fig. 11.—Non-adjustable Spanner.

An adjustable form of cycle spanner is necessary; a good form, known as the New Century, is shown at Fig. 10. A non-adjustable spanner, manufactured by the Abingdon Works Company, for adjusting ball heads, hubs, and bottom brackets, is shown at Fig. 11.

The punch shown by Fig. 12 is specially designed to pierce holes in sheet metal, such as the mud-guards of ladies' cycles.

Miscellaneous tools consist of screwdrivers, hammers, callipers (inside and outside), dividers, taper reamer of square section, soldering bit, hack-saw, boxwood mallet, cutting pliers, etc. Steel and wooden straight-edges, centre-punches, chisels, drills, etc., can also be made.

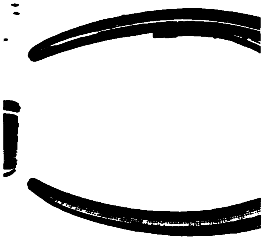


Fig. 12.—Punch for making Holes in Sheet Metal.

CHAPTER II.

HOW TO BUILD A FRONT DRIVER.

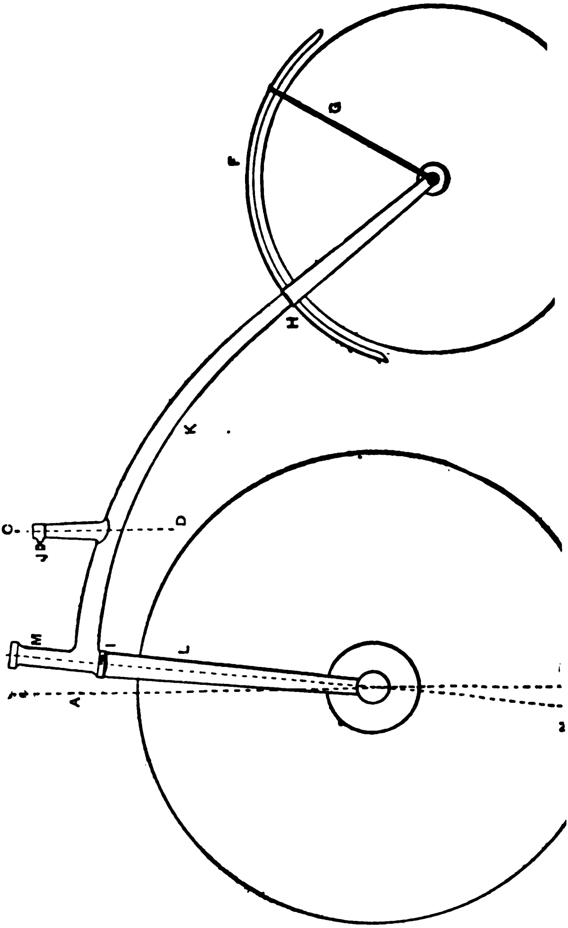
THE Front Driver bicycle takes its name from havi its larger wheel—which serves for both driving an steering—in front ; a " Safety " has its steering whe in front and its driving wheel behind. By the ge attached to the hub of the driving wheel, a 36-in. or eve smaller wheel may be geared up to equal a 50-in. 60-in., or any intermediate size, so that a " Fro Driver " is capable of a speed equal to the " Safety."

The " Geared Ordinary " machine as first introduc was built with a front wheel of 44 in. to 48 in. diamete but although this was a fairly good machine, the size the driving wheel was soon reduced, until 34 in. to 38 i was reached, and this is the general size now used. was found that the smaller wheeled machine was mu faster, and more rigid and lighter, owing to its small frame. In 1892 a machine was introduced with a small driving wheel still, 30 in. and 32 in. being the usu size.

One of the chief advantages claimed for this class machine was the absence of chain gearing, which, in it naked state, certainly has a strong affinity for dirt, dust and mud. The introduction of the Carter gear-case described in Chapter VIII., has considerably reduc this defect, and has, in fact, in this respect, placed two systems of gearing on a level. Another advan claimed was that, the rider being higher from the gro the machine was cleaner to ride ; and for winter rid this was still more noticeable. Now that the size of driving wheel has been so reduced, this advantage been considerably lessened, and, unless well protec by ample mud-guards, the front driver is quite as to ride in bad weather as the rear driver.

The working drawing (Fig. 13) is designed for a front river having a 30 in. driving wheel and a 22 in. rear heel, but these sizes need not be strictly adhered to. hey are chosen simply because they are the most suit-le for this form of machine. A geared ordinary may e built with a driving wheel from 42 in. to 46 in. iameter; but except for very tall riders these sizes are ot recommended. The next sizes are from 34 in. to 3 in., and there are many who still prefer front drivers ith driving wheels of these diameters. They are faster, pecially up-hill, and the wind resistance being less, ey must be easier to drive at high speed than those of 2 in. to 46 in.

Begin by making a full-sized working drawing, as Fig. 3, which is to a scale of 1 in. to 1 ft. Should it be de-ded to build a machine with larger wheels, the wheel se and centres will remain the same, and the wheels ay be struck from the same centres as regards distance e from the other. This applies up to a 38 in. driving d a 24 in. rear wheel. If larger, the distance between e wheel centres must be increased accordingly. A alk drawing on a large board, or on the workshop oor, is all that is required. No detail is necessary; mply the wheel centres and diameters, with the plain ele-ation of frame and forks. The vertical line A B and also he line C D to set the seat tube to should be drawn at a ight angle to the ground line. The advantage of having his seat tube quite upright, or square with the ground ine, is that it then admits of plenty of adjustment hori-ontally for the saddle, as, if the ˥-pin is bent at a ight angle, it may be turned either way, and the saddle laced in front of or behind the seat tube. This will nable the rider to obtain a position on the machine to uit him to a nicety. With plenty of rake on the front orks a forward position will probably be preferred, and ound to give best results; but with a machine built rith little rake, a more backward position will be best. t will be found that the more upright the front forks re, the easier it will be to steer the machine. A suitable rake for the front forks is shown b



line M N: this will be 2½ in. from A to M, whic
the amount allowed for in the drawing.

The term "rake" means the inclination of the f from the perpendicular, measured from the centre shoulder of the front fork crown near the letter 13), to the perpendicular line A; and it is im- t that this should be carefully measured. When to cut off a length of tube for the backbone, it e well to put the wheels in their places in the and with the whole carefully placed on the full- drawing, mark off exactly the length required with ; knock the backbone on to the neck, and stand achine upright on a level floor. Hold a plumb- o the front fork crown, exactly in the centre, and re the distance from the line to the centre of the g wheel axle; this should be 2½ in. Then finally l braze up the backbone.

e crank throw is another point in which the front differs from the rear driver. Whereas a crank of 6¼ in. to 6½ in. may, with advantage, be used ear driver having a gear of from 62 in. to 68 in., ombination on a front driver would be useless. The ıust be reduced, and the crank throw increased. ık with a pedal slot admitting an adjustment of 6½ in. to 7 in. will be about the most suitable. may be gained by paying attention to the style lalling on a front driver, the extra length of the making it necessary to "ankle" more than in order to obtain the best results from the ıt of force expended.

e diameters and gauges of tubes will be as s :—Backbone, 1⅛ in. by 18 B.W.G.; front fork sides, by 18 B.W.G., ovalled; back fork sides, ⅞ in. by 18 , ovalled; handle-bar, ⅞ in. by 18 B.W.G.; seat 1⅛ in. by 18 B.W.G., tapered to take ⅝ in. solid ┐ -pin inside; or it may be tapered to take a ⅞ in. by r.G. hollow ┐ saddle-pin, which would be lighter. gauges are for a full roadster machine, calculated ry thirteen stone. Should a semi-racer or racer uired, or a machine to carry a light-weight rider e or ten stone on the road, then the forks may B.W.G. Handle-bar, ⅞ in. by 20 B.W.G. (with no brake); seat tube, 20 B.W.G.; hollow ┐ saddle-p 16 B.W.G.

When the wheels are made, the next thing will be fit the front forks to the hub bearings. To do thi remove the bearings from the hub, mark the side eac bearing belongs to, and carefully fit each to a for care being taken that the best side of the forks com outside. Dents and imperfections occasionally occu on one side of a fork, and these should be fitted that they are out of sight. Most geared hubs have

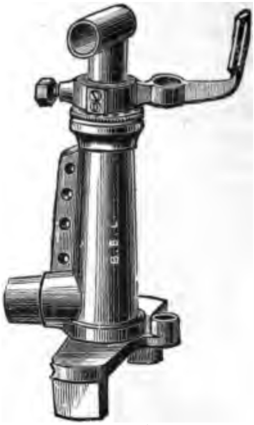


Fig. 14.—Ball Head for Front Driver.

loose piece to fit and braze into the fork, which i fastened by bolting it to the bearing. In brazin these pieces to the fork, take care that no brass borax get on to the machined parts or into the bo holes. A good plan when brazing is to cover with cl any parts requiring protection from heat.

Cutting Forks off to Length.—Cut off the forl in *exactly* equal lengths, making due allowance for tl amount of clearance which it is proposed to allo between the tyre and the fork crown. Examine tl ball head (Fig. 14), and see how far the joint of tl oulder is below the under part of the crown. Supsing it to be ½ in., and that with a 30 in. wheel it is oposed to allow 2 in. clearance when finished and with e tyre on, screw the bearings on the forks, and measure ⅝ in. from *centre* of the bearing; the extra ⅛ in. is lowance for fitting. Cut one fork off square, and the her exactly to it.

In fitting and brazing the forks to the head, square oth fork blades; for brazing, clean the inside, removing l scale, etc., for about 2 in. all round (this applies to all razed joints, which should be well cleaned); then fit e blades to the head lugs. The lugs should be so filed at when the blades are knocked on, the bearings e the same distance apart as they were when in osition on the hub. This is very important, so also the following: After both blades have been fitted o the head lugs, remove the head and adjust the rk bearings (with blades attached) in their proper laces on the hub. The top ends of the fork blades hould now come in such a position that the head ugs will drop into them without *straining* the blades ither way to do so. If they do not, then bend them till hey do, heating the blades as close to the bearing s possible. Whilst trying the head lugs in the forks, crew the bearings up tight, so that there is not the least possible shake in them. These two operations will ake a considerable time to do properly, but the time pent will be doubly repaid in the easy running and vear of the machine. The object to be attained is to et the two bearings *perfectly* true, one with the other, vithout any strain or twist.

Before brazing, see that all the joints are well fitted; hey are very liable to gape open when drilling for the egging screws, and care should be taken to prevent his. If only very slight, the gap may be closed with a ammer and bound round with fine iron wire. In fact, he closing should be done in any case, as it makes a ood tight joint, and also prevents the brass running way from the joint too freely. Before brazing, see that the head tube is upright with the forks a not as Fig. 16, and that both blades are of ex same length. After taking from the fire, do not

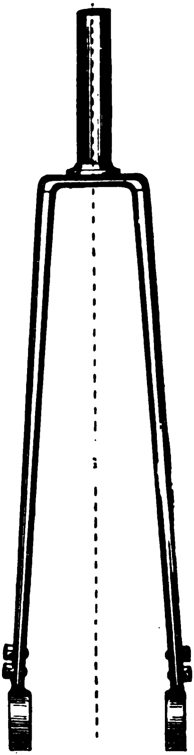


Fig. 15.

Fig. 15.—Head Tube and Front Fork properly set.

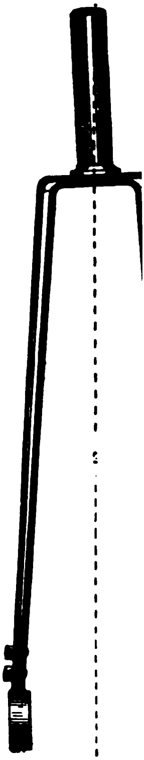


Fig. 16.

Fig. 16.—Head Tu Front Fork imprope

the hub from the forks until the joints ar cold.

Setting.—Finally set the bearings true with t and with each other. To ascertain if they are out

move the hub, but let the bearings be firmly bolted to
e forks. With two short straight-edges applied one
each inside face of the two bearings, try in every
rection if the straight-edges are parallel with each
her ; if not, set the bearings true by heating the blade
ose to the bearing and twisting in the required direc-
on. Before shifting either of the bearings, however,
easure the distance they are apart when taken from the
ub, and see that they are the same when the setting is
ished. Another and better way to set the bearings
ue with each other, when their construction allows
it, is to screw or otherwise fix the collars in their
aces on the axle, with balls in and firmly adjusted,
hen take a plain mandrel which will just pass through
e of the bearing collars, and if it can at the same
me be passed on through the two, they are true.

Making Back Forks.—Flatten the back-fork blades
t their small ends for about 1 in., and braze the closed
rfaces together if preferred ; it is not necessary to do
, but it makes a slightly firmer job. If it is decided to
raze the ends, thoroughly clean the insides before
osing, to enable the brass to take. Mark off the ends
ntrally and drill them to receive the *shoulders* of the
ub-cones, and *not* the spindle. By having the cones
ting tightly into these fork ends, a much firmer and
fer job is ensured. It is not advisable to trust to the
rength of the spindle alone to support this part.

When fitting curved blades, compare them to see that
ey are of equal curvature ; if not, make them so by
ightly increasing the curve of one or decreasing that
the other. If very much out, a little on each
ill be advisable. Cut the blades off of equal length,
easuring them carefully with, say, a spoke wire, with
inch of one end turned at right angles to the main
rt. This turned back part can then be placed in the
le-hole, and the long end filed off flush with the top of
e blade, as Fig. 17. The wire will then do to measure
f the other blade, and any subsequent blades for
her machines with the same sized back wheel. The

length of the blades must be regulated by the pat the fork crown used, and the amount of cleara is proposed to allow between the tyre and

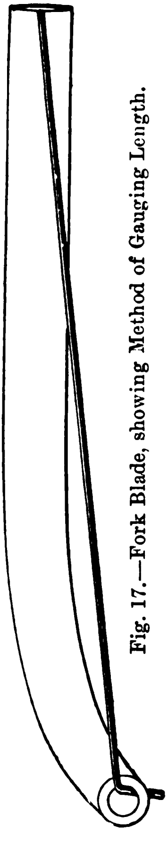


Fig. 17.—Fork Blade, showing Method of Gauging Length.

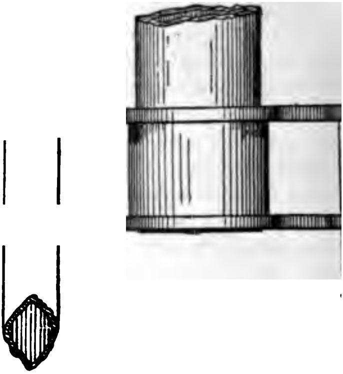


Fig. 18.—Double Plate Fork Cro

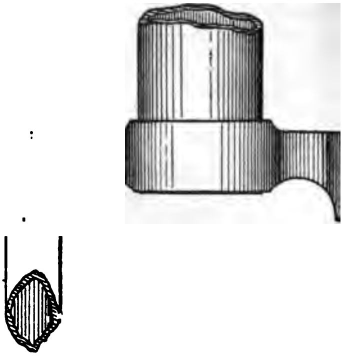


Fig. 19.—Humber Pattern Fork C

part of the crown. The drawing (Fig. 13) is de for 1½ in. clearance, which will be found ample, w looking unsightly.

f a crown is used, the blade joints of which come with the lowest part of its centre, and the wheel is ı. in diameter to allow 1½ in. clearance, the blades be finished 12½ in. long, measured from *centre* of spindle hole). Some fork crowns will require the es to be cut off longer than this to allow the same nt of clearance under the same conditions. In the le-plate crown (Fig. 18) the blades pass right through two plates ; so that with this and the Humber rn crown (Fig. 19) it will be readily perceived that lades must be as much longer as the distance is from ottom of the crown to top of the fork holes. In the of the crown of ordinary pattern (Fig. 20) it will be ed that the ends of the blades are level with the r part of the crown. The double-plate crown is the gest and lightest of the three when properly fitted razed. It can be made readily by hand by marking utting out the two plates from 12 or 13 B.W.G. mild plate in the form of Fig. 21. These should be d on to the backbone in the following manner :—

itting Back Forks to Backbone.—Clean the tail end e backbone outside, freeing it from all scale ; also the two plates on both sides and around the for the backbone and blades. Fit one plate o the backbone ⅞ in. from the end, then cut off , and fit ¾ in. of tube, of a size to fit the out- of the backbone, with its end flush against the already fitted. The second plate may then be l on, with a bearing against the lower end of the piece of tube, which will bring it square with the plate and at right angles to the curve of the back- . Slightly rivet up the tail end of the backbone, h should project about $\frac{1}{16}$ in. through the second to prevent the latter dropping off in the fire. short piece of tube fitted between the plates s a better or an increased brazing surface for the s, and also considerably strengthens the backbone een them. When these plates have been set ctly true, with the blade holes in a direct line with each other, so ; es are in they will be para each other, bras on, taking care to leave of brass in the for strength. When cool, nt the blades in the In doing this see that they fit really well, otherw the brazing surface is so all the brass will away from the joint and ve any badly-fitting exposed. It is a good p to bind some thin wire round the joints close u o the corners. This keep the brass fr running away from them

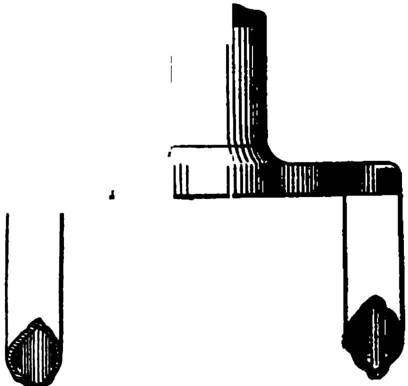


Fig. 20.—Ordinary Pattern Fork Crown.

also round off the angle. In filing up be careful maintain this roundness; it greatly strengthens joints if they are finished with a small round instead of being taken sharp in with the square co of a flat file. Fig. 22 shows the corners above below the bottom plate finished round; in Fig they are filed sharp in. If these two joints are amined it will readily be seen that Fig. 22 has tl times the holding surface that Fig. 23 has; moreo the junction of the blade with the plate is graduat and this is always a desirable object to attain. Scr the back hub-spindle and cones between the fo ends to set them at the same distance apart as tl hen the hub is in its place. Screw the nuts up , and the forks will be ready to braze after two l plates of steel, as Fig. 24, have been fitted in the of the blades to close them. As these joints can- be pegged (*see* p. 29), great care must be taken not hift them when brazing; therefore, before heating i, see that there is no spring or strain on the s tending to displacement. Place the forks on fire with the bottom blade horizontal, and braze at a time, having the blade which is being brazed ys at the bottom. Remove from the fire carefully st each joint is running and twist the work about listribute the brass well round the joint. When brass has set, scrape off as much of the borax, etc., ossible whilst still hot, as this will be rather an ward part to file up afterwards.

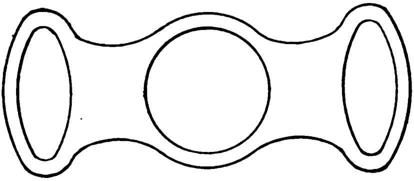


Fig. 21.—Plan of Plate for Double Plate Crown.

utting off Backbone for Rake.—The amount of to give the front forks is determined by the th of the backbone. To obtain the rake exactly for wheels in hand (30 in. and 22 in.), will require ul measurements and observance of the following tions :—Place the front wheel with the forks, head, neck all in position on the full-sized working ing, with crank axle quite central with the eter of the wheel and with the ball head and forks d so that the rake line on the drawing runs quite al up them. Then, with the back wheel adjusted in orks, lay the backbone along the drawing with the e of the back-wheel spindle on the centre of the wheel on the drawing. Then with the bases of ls quite level on the ground or base-line on the drawing, carefully mark on the backbone where th of the neck will come to when fitted, and cut it off ¼ in. longer to allow for uneven cutting off and i If the backbone is not properly bent to sh will be advisable to correct it before cutting much out, alteration of the curve will affect th if cut off before the curve is altered.

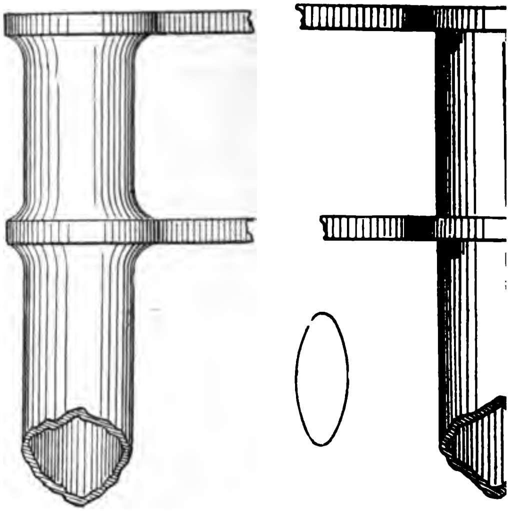


Fig. 22. Fig. 24. Fig. 2

Fig. 22.—Correct Method of filing Corners of Doubl Crown. Fig. 23.—Incorrect Method of filing of Double Plate Crown. Fig. 24.—Blank fo End of Fork Blade.

Fitting Backbone to Neck.—Clean out the in the backbone for about 2½ in. up, with a half-rou and, if the neck is already turned, fit it to the ba so that the joint comes level with the mark made previously. Chamfer off the inside edge of the bone to allow a good close fit to the neck. neck is solid where it enters the backbone, d ıs possible without breaking through a hole $\frac{1}{4}$ in. in diameter than the diameter of the turned part .e neck. This not only lightens it, but facilitates ng and lessens the liability to break the backbone ıis point, which is very liable to occur with a neck. Experience has shown that a backbone ıg a *solid* neck brazed into it is certain, sooner ter, to break just below the neck. The vibration ing up the backbone is suddenly checked by the of solid metal in the neck and causing the fibre of ube to crystallise. With a hollow neck this vibra- is checked gradually, and the more gradual the the better. The chances of fracture may be re- l to a minimum by boring in the neck a hole, ıe size given, and then coning it out so that nouth gradually slants to a thin edge.

hip two narrow channels on the surface of the to allow brass to run freely along the joint when ng. As this joint should fit very tightly, these nels are necessary. Fit a blank into the hole in neck to prevent the brass from running into it ad of round the joint. Knock the neck home in ackbone, set it upright, and it will then be ready egging.

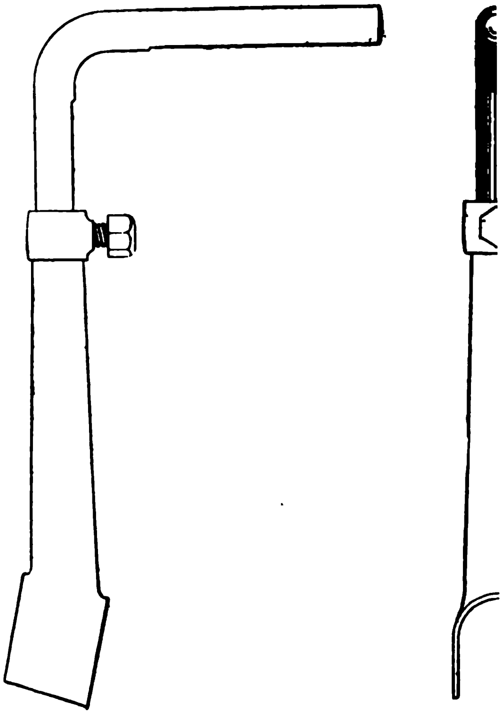
'egging.—When the neck is set perfectly upright, put crewed piece of wire peg to prevent it shifting. To sure that it is upright, adjust the head and neck her with the backbone and the front wheel between 'orks, and see that the backbone truly follows the wheel. If so, put in a screwed peg, without ing the neck, and braze up. If the back-fork n used is one which does not leave exposed the of the backbone, load the joint with brass and before finally knocking in the neck. But with louble-plate crown this will not be necessary. The ation of brazing is dealt with fully in Chapter VII.

'etting Back Forks.—If the back wheel has been true, the back forks may now be set true — or may be done before fitting the neck to the

backbone. Adjust the wheel in the forks wit loose or adjusting cone on the left-hand side of machine, and if the wheel runs central between t with a straight-edge held to the side of the rim, if it is true with a given point of the backb say, 9 in. from the back crown, trying it on side and observing if there is an equal amoun space between the straight-edge and the backbon each side; if so, it will do. Should, however, wheel *not* run centrally between the forks, then ei the wheel is dished or one blade is slightly longer the other. Ascertain which, and correct the error. one blade is slightly longer than the other, say, $\frac{1}{3}$ they may be adjusted as follows:—If, say, the wheel at the crown is nearer the right-hand blade, then *slig* increase the curve of that blade, or slightly straig the other, or a little of each may be done, and in case it will be less noticeable. If the back forks straight ones, the only way to correct a slight equality in the length of them is to file the hole the ends; but these are unworkmanlike processes, make a clumsy job. If the wheel is not dished, it is a good deal nearer one blade than the other, braze the longer one of them and shorten and re-b it. The best way to avoid having the blades une in length is to take time in fitting them to the cr and be sure that they are right before brazing up.

Making and Fitting Seat-tube to Backbone.— working drawing (Fig. 13) shows a seat-tube made fitted for a solid $\frac{5}{8}$ in. ┐ saddle-pin, as Fig. 25; but thi course, is entirely optional. It may be made so, or to a $\frac{7}{8}$ in. hollow ┐ saddle-pin, as Fig. 26, in which case ┐-pin is held in place by the lug fixed to the top of tube being split and drawn on to the ┐-pin by a $\frac{3}{8}$ in. passing through one side of the split lug and screv into the other side. With this form of seat-tube, ┐-pin must be well fitted in a smooth hole before the tightened up. With a seat-tube and solid ┐-pi ig. 25, the tube must be tapered down to a size will freely admit the ⅝ in. solid ⌉-pin, which is held rigidly to the frame by a ⅜ in. pin screwing into and through the lug brazed to the top of the tube, and binding against the ⌉-pin, which should have upon its face a flat, filed or milled, to better enable the ⅜ in. pin to hold it securely. The seat-tube and ⌉-pin shown in Fig. 26 are lighter than those in Fig. 25, and look better; and unless the reader has a pair of blacksmith's top-and-bottom swages of suitable size, it will be necessary to get the tube for Fig. 25 tapered by a blacksmith. The seat-tube for Fig. 26, however, may be made from a piece of 1 in. tube and left parallel for the ⅞ in. hollow ⌉-pin to fit into. It may be fixed to the backbone by a suitable lug connection or a lap joint. In making a lap joint for this part, saw down and open out the tube at the correct angle, so that when fixed to the backbone it will be perpendicular in each direction. To make this lap joint, mark a straight line down each side of the tube, and, with the tube placed on the drawing, mark off 2 in. on the line at the back, also mark off on the line at the front the point where the top line of the backbone bisects it, the tube being upright and parallel to the line for the seat-tube on the drawing. Saw down to these marks, keeping to the lines, which is rather difficult to one not used to a hack-saw; and, with the tubes heated to a bright red, open out the joint, first using a round mandrel about ½ in. or ⅝ in. diameter, and afterwards one of a diameter equal to that of the backbone (1¼ in.).

When this is done, one side of the joint will be considerably longer than the other. Measure the circumference of the backbone with a thin piece of tin, or even twine, and see that the short side of the joint is of the proper length to go round it without overlapping. If it is, cut off the other or long side to correspond. Clean the joint well from scale, also the backbone where it is to fit. Tap gently round the backbone till a good close fit is obtained, taking care not to dent or bruise the tubes in doing so. When fixed perfectly upright by a couple of pegging screws, proceed to braze the joint. Before this finally fixed to the backbone it should, of course off to the length required to suit the height of th and the adjusting lug should be fitted and bra The length of the seat-tube in Fig. 13 is suitab rider of about 5 ft. 10 in. or 5 ft. 11 in. Allow or off this for every 1 in. above or below the mentioned. For instance, if the rider is 5 ft. 8 i make the tube 1 in. shorter than shown on th ing drawing. A sure way to ensure the machin made to rider's reach is to measure the length of from the crutch to the ground ; then the distan



top of the saddle to the pedal-plate may be 1½ in. re than that measurement, taken when the ⅂-pin is f-way in the seat tube.

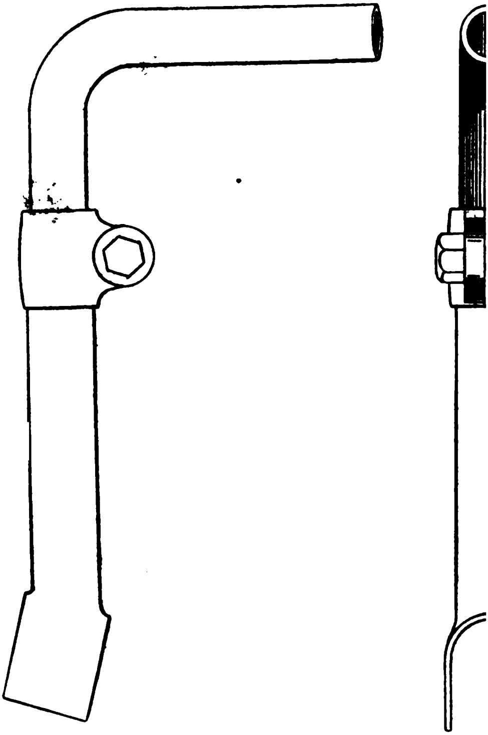
Making ⅂- *or Seat-pin.*—If it has been decided to re a solid ⅂-pin and to make a seat-tube for it, take in. of ⅝ in. round Bessemer steel, and turn it to fit seat-tube. Mark off 6 in. from the end, and bend it re at right angles as sharply as possible. Having arm longer than the other admits of alternative ustment; and, being bent to a right angle, the pin y be reversed in either direction. File or mill the on both arms of the ⅂-pin, as shown.

For a ⅞ in. hollow ⅂-pin, take 11 in. of tube ⅞ in. 14 B.W.G., and mark off 6 in. Fill the tube tightly th fine sand. Make three or four heats, and bend dually, holding one end in the vice or wooden e-block, and pulling the other end with a piece of ger tube slipped on over the end. Care must be en to ram the tube tightly with the sand, or it will sure to kink at the second or third heat.

Setting.—The machine may now be finally set. e front fork bearing has been, or should have been, eady set, so that both bearings are *perfectly* true th each other. With them and the hub bearings th carefully adjusted, the hub or wheel should freely rolve without any perceptible unevenness or tightness; careful to get this part *perfect*, as so much depends its being absolutely true. See that the handle-bar parallel with the front axle, and that both handles of equal height from the ground and the centre of e head. Set the backbone to truly follow the radius the front wheel, after which try with a plumb-line the rake of the front forks is correct, and next set e back wheel to track with the front. Turn the chine upside down, and with a straight-edge held ainst the rim of the back wheel, try if it is in a e with the front rim, which it should be if both ns are of the same width; but if the front rim is in. and the back rim 1⅜ in., make due allowance.

Try the straight-edge in different parts of the case of any inequalities or unevenness in them.

In testing the rake of the front forks, see machine is standing on a practically level surface the tyres are not in the rims, and they are of



diameters, have the rims packed up on someth will bring them to the correct distance from the The tyres themselves may be placed on the grou the rims stood on them. To make sure of the l of the floor, try the machine both ways—that the back rim resting on the exact point where the front rim was when first testing for the rake.

Filing-up.—Take the machine to pieces, and file up all the joints, etc., smoothing and emery-clothing all parts to be enamelled, such as forks (inside and out), backbone, head and seat-tube. The finish and beauty of the enamel will depend largely upon this preliminary polishing of the tubes. The final polishing with emery-cloth may be left till after the machine has been tried.

Fixing-up for Trial.—It will be advisable to fit the machine up again, with the tyres on, and the saddle, pedals, etc., in position in order to see that everything is satisfactory. Give the machine a good spin of ten or twenty miles. Something may be defective or may want altering, or a brazed joint may be unsound; at any rate it will be time well spent. Even in a well-regulated, up-to-date manufactory it is surprising to note the number of small defects one finds in machines upon thorough examination; and they are likely to occur even more in a machine made by a novice.

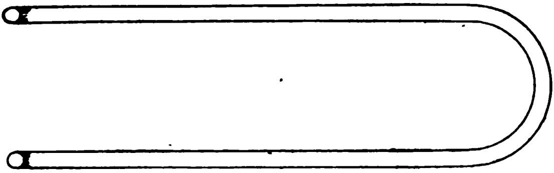


Fig. 27.—Trousers- or Leg-guard.

Leg-guard.—A regular mud-guard is frequently dispensed with on the front wheel, and some arrangement fitted to simply protect the legs from the tyre. This may be done by fixing two short pieces of stout wire, one on each side of the front fork, with their ends rounded long enough to keep the leg from touching the tyre; or instead of two wires one piece bent in the form of an elongated U, as shown at Fig. 27, with the ends soldered or brazed into the corners of the front fork-crowns can be used. The ends may be turned back for

¼ in. to ⅜ in. at right angles, and fitted into hol
in the crown to receive them. A very effecti
is made by having a leather flap cut to fit
back-bone, and to hang down on each side of
This acts as a leg-guard and mud-guard as well.

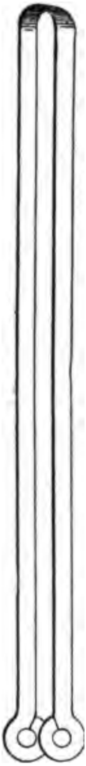


Fig. 28.—Mud-guard Stays.

king Mud-guard.—Perhaps, however, th
prefer to fit a mud-guard proper to the fron
to the back wheel, in which case it will be
y them both ready rolled to the correct radiu

one mud-guard for a 30 in. and one for a 22 in. wheel. ey should be of a greater radius than these sizes to operly follow the radius of the wheels, as they are ted as far from the tyre as the clearance between the rk-crowns allows. The front wheel is 30 in. in diameter, d the clearance between it and the crown is 2 in. Then, operly, the mud-guard should be 17 in. in radius. eing made of very light material, metal mud-guards ay be sprung an inch or so either way.

The mud-guard stays may be made from $\frac{3}{16}$ in. round r from $\frac{3}{8}$ in. by $\frac{1}{8}$ in. flat Bessemer steel. There will rather less work to do by using the flat stuff. Cut f sufficient to allow for the bend and the two eyes. rge the eyes to fit the screw which it is intended fix them with; they may be held in place by passing e top bearing-screw through them before screwing em into the bearing. In forming the eye, make it ith the end turned so that the friction of the bolt-ad tends to close the eye instead of opening it, as it ould do if turned the other way. When both eyes e forged, find the centre of the rod, and bend to form own at Fig. 28, taking care that both arms are the me length when finished. If one arm is longer than e other, it will throw the mud-guard over to one side the wheel. Fit the bend in the centre to the section the mud-guard, and secure by two copper rivets; or e stays may be brazed to the guard. A brazed joint awkward to file up on a mud-guard, owing to the fficulty of holding it in a vice. The stays may be ted either inside or outside of the guard. If out-de, the inner part is left free from obstructions liable accumulate mud, though with 2 in. clearance it is t very likely to clog, even if the stays are fitted inside. or the front guard, stays should be fixed about 6 in. om the tail end. Flatten the top end of the guard to under the fork-crown, and secure it by two small rews passing through the guard and screwing into the own. If it is decided to fit this form of mud-guard, will be as well to drill and tap the two holes for the screws before fitting the head to the fork-bla or difficulty may be experienced in drilling th when the blades are brazed on. Take care, howe in brazing to keep the brass and borax from runn into and filling these holes. This may be preven by plugging them with soft fireclay, or ordinary fi clay will do. As an extra precaution, the holes n be blackleaded, and then plugged with clay. A other parts which may stand a chance of being fil up or covered with brass in brazing may be simila treated. The back mud-guard should be made fitted in the same manner; but instead of flatt ing one end to screw under the crown, bring the gu right through the crown towards the front wheel about 8 in., and form the flat about that distance fr the end to fit to the crown. Bringing the guard thro thus will protect the rider's feet and calves in mu weather. The stay-eyes can be made to pass over ends of the back wheel spindle, and can be held in pl by back wheel nuts.

Fix the back wheel between the forks, with adjusting cone on the left-hand side. Next put front hub gearing together, being very careful get every part *perfectly* adjusted and secured. the brake-spoon in the crown and the mud-guard, any, and fit the wheel between the forks, so that th is no side-play. Fit and fix the cranks to the a and see that they are square one with the other. the ┐-pin in its place, and put the ball-head toget adjusting it rather firmly, so that there is no play in backbone when shaken from behind. Stick the han on the handle-bar with hot tyre cement, wiping off superfluous cement whilst hot with a rag or piece "waste" dipped in paraffin. Fit the brake-lever and remainder of the brake-work; also the handle-bar in fork-tube, first having put the lamp-lug and ball-h locking-nut in their places.

After the saddle and pedals have been fitted, an general overhauling has been made to see that all n and screws are firmly secured, the machine will be ready for the road.

If a mud-guard has been fitted to the back wheel, it should be fixed in its place before putting in the back wheel. In putting all ball-bearings together, the wearing surfaces should be thoroughly cleaned, and any bits of enamel which may have got into them should be carefully scraped out. A drop or two of oil should be run amongst the balls whilst putting them together.

CHAPTER III.

BUILDING A REAR-DRIVING SAFETY.

IT is a curious fact that the original "boneshaker" l with its wooden wheels and iron tyres, bore a s resemblance to the modern safety : it had nearly wheels, from 30 in. to 36 in. in diameter, whicl connected by a backbone and fork similar to the r frame. It was, however, driven with cranks front wheel, and was not geared up ; where modern safety is usually driven by cranks and from the rear wheel, and may be geared up extent.

The machine about to be described will be when finished, provided good and careful work into it, able to stand comparison with the ver in general outline and appearance it is like tl makes.

The frame is that known as the Humber p with long wheel base, long ball head, barrel b light weldless steel tubes, $\frac{7}{8}$ in. diameter, 18 dropped handle bar, detachable mud-guards, cranks, solid block chain or roller at option, gear rider's requirements and district. Both whe 28 in. in diameter. Tyres will be decided la Spokes direct or tangent, as desired. The mac designed to carry at least 12 st. 7 lb. on fair ro is adjustable to suit riders from 5 ft. 3 in. to height, and will weigh when complete, with ligh matic tyres, 36 lb. all on. If a pneumatic tyre i used, be careful to have a front fork crown wide to give at least $\frac{1}{4}$ in. clearance on each side betw tyre and the fork.

Working Drawing.—It will be a very good make a full-sized working drawing from the on sented by Fig. 29 or Fig. 30, or of any other patt r be chosen. Details are unnecessary, but simply areful drawing, to show exactly the rake lines of down tube and the steering tube; the rake of the ring is especially important, as on this depends, a great measure, freedom and ease in steering the hine.

The tubes should be measured off when the draw- is completed; they should enter the various lugs ar as indicated by the arrow heads in Fig. 29. There o rule for graduating the gauge of the tubing to espond with the rider's weight; this can be arrived

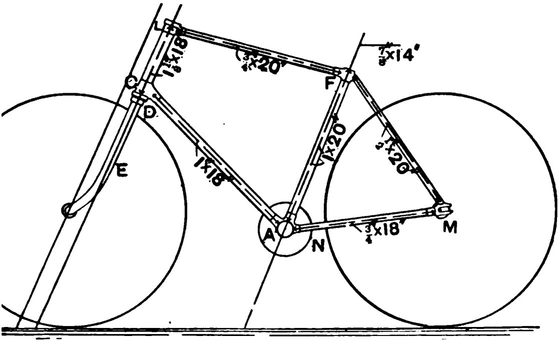
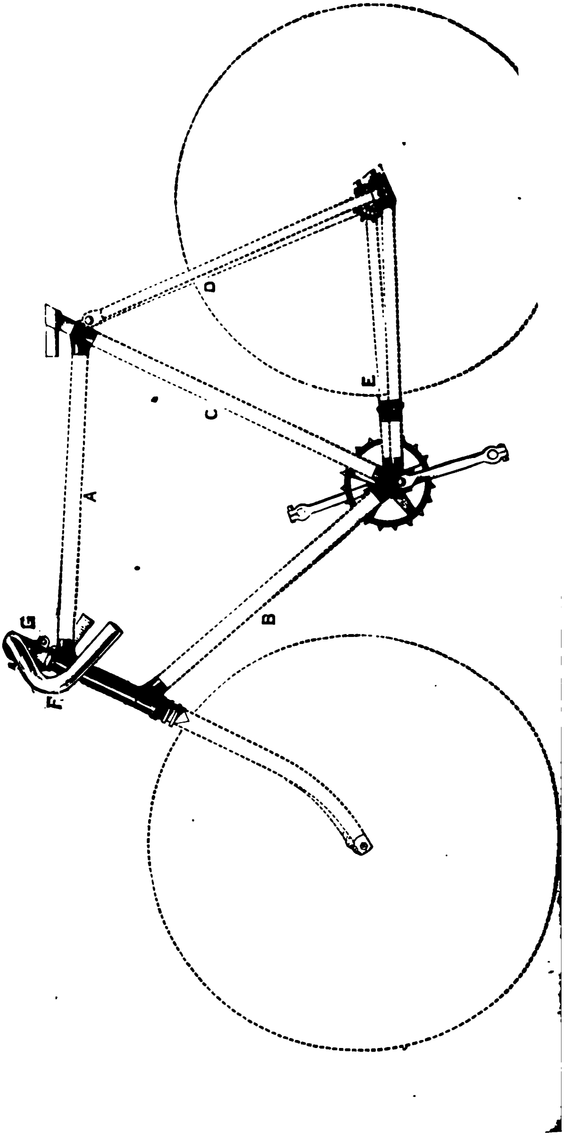


Fig. 29.—Working Drawing for Rear-driven Safety.

only by experience. The gauge of the tube to be d depends on the class of tyre on the wheel, the con- on of the roads on which the machine is likely to run, l on the style of rider. One man of 9 stone may sh up a machine that another of 10 stone has ridden h safety.

The tubes required to build Fig. 29 are as follow:— down tube from seat-lug (F) to bottom bracket (A), n. in diam. by 20 B.W.G.; two bottom back stays, m fork back ends (M) to bracket (A), ¾ in. diam. by B.W.G.; two top back stays, from seat-lug (F) to back k ends (M), ½ in. diam. by 20 B.W.G.; one top front tube


D
C
E
A
G
B
F

from top head-lug (L) to seat-lug (F), ¾ in. diam. by 20 B.W.G.; one bottom front tube from the bottom head-lug (C) to the bracket (A), 1 in. diam. by 18 B.W.G.; one head tube to connect the head-lugs at the top (L) and bottom (C), 1⅛ in. diam. by 18 B.W.G.; one steering tube to front fork, 1 in. diam. by 16 B.W.G., the length of this front fork tube is determined by the pattern of the crown (D), and the kind of lamp-lug used; one handle-bar tube, ⅞ in. diam. by 18 B.W.G. (from 34 in. to 36 in. long, according to the amount of drop and sweep desired); one handle-bar down tube, ⅞ in. diam. by 16 B.W.G., of a length to suit the height of the rider and the description of joint that is to be made to fit the handle-bar. For a lap-joint, 10½ in. will be found a good average length. The handle-bar down tube should be bought to telescope into the steering tube, and this it will do if both are 16 B.W.G. thick, and exactly ⅞ in. and 1 in. respectively in diameter. A seat tube will also be required, ⅞ in. diam. by 14 B.W.G., of a length according to the reach of the rider, 11 in. being a good average. To ensure a good

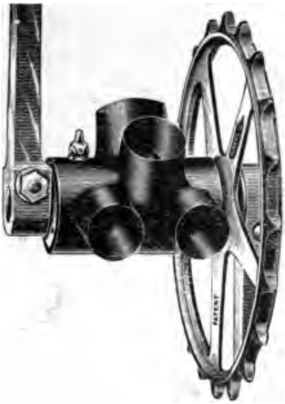


Fig. 31.—Bottom Bracket with Chain Wheel and Cranks.

fit in the down tube, it should be o fit in tubing 1 in. diam. by 20 B.W.G. -pin m be made of two parts, lap-jointed, either of two pie of $\frac{7}{8}$ in. diam. 14 B.W.G. tube, or of one piece of tu and one piece of $\frac{5}{8}$ in. round steel; the two tubes w make the lighter and better job, and saddles may bought with lugs to fit either $\frac{5}{8}$ in. or $\frac{7}{8}$ in. seat-pins.

Fig. 30 shows Perry's design for a rear-driver. The tubes are lettered as follow :—A, top tube; B, bottom tube; C, down tube; D, back stays; E, chain stays; F, head tube; G, handles.

The bottom bracket may be bought made up complete with cranks, as shown at Fig. 31; but for those who decide to make their own bracket the following is the method of going about it: First make a full-sized drawing, as Fig. 37; draw the axle threaded to a size best suited to the screwing tackle available. Supposing that the axle for the adjusting cone is screwed with a $\frac{5}{8}$ in. thread, allow a full $\frac{1}{16}$ in. on the nose or thin edge of the cone, strike a circle $\frac{1}{4}$ in. larger in diameter to allow for the diameter of the balls in the bearing; then draw the cup, allowing $\frac{1}{16}$ in. for its thickness. Measure the extreme outside diameter of the cup, and procure a pair of steel stampings of the shape shown in Fig. 32. A cup with flat turned back and sides will give a firmer hold in the bracket than one with round corners, and the inside gives two points of contact for the balls, so forming a steadier bearing for them than the rounded cup (Fig. 33).

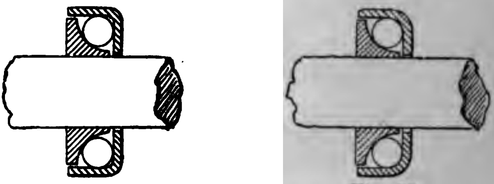


Fig. 32. Fig. 33.

Figs. 32 and 33.—Cones and Cups in Section.

In boring-out a hole to receive the cups, unless you have special cutters for the job, chuck the bracket on he lathe, and bore the hole out very accurately, so hat when finished the cups will require a little gentle apping to force them in. Do not yet fix them in permanently, or when the bracket is brazed the heat will soften them. For the present, lay the cups aside. Proceed to drill or bore the bracket to receive the bottom back-stays, the down tube, and the front bottom tube, taking care to drill the holes in at the exact angle at which the frame tubes that fit in them will project. The centre lines shown in the full-sized drawing will here be wanted. Cut templates in zinc, tin, or any

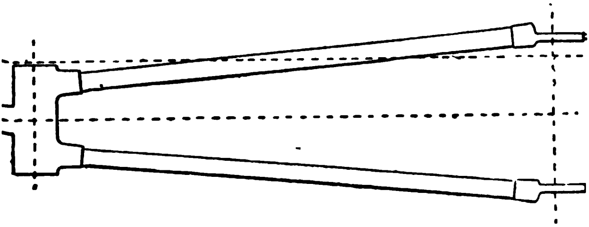


Fig. 34.—Plan of Chain Stays, showing line of Chain.

ight sheet metal to all these angle lines (Fig. 29)—amely, one each for the top head-lug, the bottom ead-lug, the seat-lug, and the fork-ends, and three or the bottom bracket, one to give the angle between he down tube and the front bottom tube, one for the ngle between the down tube and the bottom back-tays, and one for the angle between the back-stays and he hub, which the working drawing (Fig. 29) does not how. To cut this last template it will be advisable o make a full-sized drawing, as Fig. 34. This is based on the pitch-line of the back or driving hub—that is, he distance from the *centre* of the hub chain-wheel o the *centre* of the hub. The *centre* of the bottom bracket chain-wheel should be the same distance from he centre of the bracket as the centre of the hub is from the centre of the hub chain-wheel. It is practi ally the centre line of the chain from an imagina line drawn through the centre of the machine. Th position is important, and should be carefully worke out and adhered to. If a vertical drilling-machine used, fix the bracket to an angle-plate on the table then tilt or pack the angle-plate up to the angle of th back-stays, as shown by the angle template cut f that purpose. The holes for the down and the fro bottom tubes are drilled 1 in. in diam. at right angl to the centre of the bracket, so that an angle-pla of 90 degrees will require no packing, the bracket bei simply bolted to its face, care being taken to get the ang between the front tube and the down tube correct. I drilling large numbers of parts in a large factory, separate angle-plate is kept for each particular lu If a vertical drilling-machine is not available, the lu may be drilled on the lathe by bolting a lug to th face-plate and boring it with a tool held in the slid rest, or with a drill supported by the back-centre, a held by a carrier or spanner, or in any other mann suited to the lathe appliances available. When th bracket has been cupped out and drilled to receive th various tubes entering it, put it by.

Examine the chain-wheel casting; if it has warpe or got knocked out of truth in the annealing oven, ta it into shape on an anvil. Clean the sand out of th axle-hole, chuck the casting true and bore out a $\frac{3}{4}$ in or $\frac{11}{16}$ in. hole to receive the axle. Remove it from th chuck, and with a round file make three or four sm channels, about $\frac{1}{32}$ in. deep, through the hole, to allo the brass to run in freely when brazing the wheel the axle. For the axle, procure about 7 in. of Be semer steel, $\frac{3}{4}$ in. or $\frac{13}{16}$ in. in diameter, centre it, a turn one end to fit tightly into the hole bored throu the chain-wheel so that force is required to drive in; otherwise, when the wheel expands with the he in brazing, it may shift on the axle. The position the chain-wheel on its axle will be determined by thickness of the bosses on it, by the thickness of the crank, and by the width of chain used.

The axle can be cut off to the exact length after the cranks are fitted, so it is well to have it a trifle long to begin with. Braze the chain-wheel to the axle; make a sound braze of this important part. Feed with *brass* from one side only, and draw it through with *borax only* till the brass appears on the other side of the boss, and thus make sure of having a sound joint brazed from end to end. With a very tight-fitting wheel fed with brass from *both* sides, the solder may run round the edges only and not reach the middle, and so make an unsound braze. The process of brazing is fully dealt with in Chapter VII.

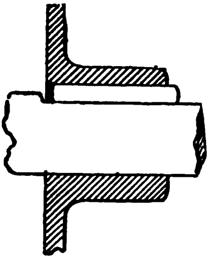


Fig. 35.—Chain Wheel Keyed to Axle.

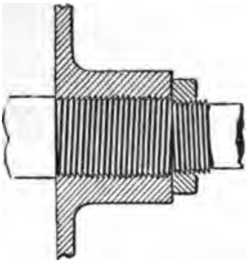


Fig. 36.—Chain Wheel Screwed on Axle.

There are several methods of fixing chain-wheels, but the above is generally considered one of the best. Other methods adopted by good manufacturers are illustrated. Fig. 35 is simply a flat key fitted and driven in. When thoroughly well fitted by a good workman, it answers very well, but otherwise, in most cases, it would probably come loose sooner or later. Fig. 36 shows the method of screwing the chain-wheel on the axle. In this the chain-wheel must be screwed on with a *left*-handed thread up against a shoulder, and kept there with a locking-nut having a *right*-handed thread. Properly fitted, this is a satisfactory job, but the brazed joint is simple and sure when pro done. For lightness, the axle between the en the thread and the chain-wheel boss may be tu down to about $\frac{9}{16}$ in. diam. (see Fig. 37); then ro turn the ends, leaving them of full size for fitting t cranks later on; or if the cranks are now ready b fit the axle to them and finish its ends straight a but leave the centres in.

To make a perfect job of the chain-wheel tee milling-machine and a milling-cutter to suit the and pitch of the chain will be required, but with pat and skill the teeth may be marked and accurately sh with a file. The chain should be used to try the

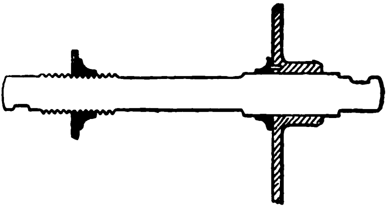


Fig. 37.—Section of Axle with Cones in Position.

by; it should bed well down on the wheel, and yet no play between itself and the teeth. Chain-w may be bought ready milled and bored to suit chain, and with any number of teeth.

In screwing the axle for the cones, the fixed may be screwed on a right-handed thread, and the cone on a left-handed one. The loose cone s certainly have a left-handed thread, as it cannot run up and jam against the balls, as may happen a right-handed thread. Screwing the axle to fi cones is always to be preferred, but if solderi adopted, well clean the cone and the axle with cloth; then with tinman's solder and a solution of chloride as a flux, tin the two surfaces. When tinned, bring them into position, and heat the th a blowpipe or Bunsen burner till the solder melts; ɜn press the cone home, and cool the work at once th water. If this is carefully done, the temper of the ıe will not be let down; but it is impossible to *braze* thout softening the tempered steel.

Take the cone stampings, bore and tap them to size, d turn them to shape shown in Fig. 32. A screwed ındrel will be required to turn them upon; one with slight taper in the thread will be preferable. Try cones with the balls in the cup to see that they run oothly and *hide the balls.* Do not leave much play ween the edges of the cones and the cups, or dirt

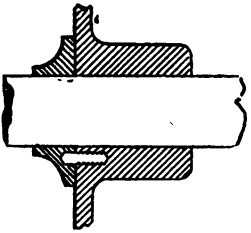


Fig. 38.—Method of Pegging Chain Wheel Boss.

d dust will get in the bearings. Unless everything is ad true, it will be better to leave a bare $\frac{1}{32}$ in. clear-ce, or the edge of the cones may bind against the cups. ıurl the edge of the adjusting cone for convenience tightening it up with the thumb and finger.

The fixed cone may be screwed on as shown at g. 37, or it may be fitted plain against the chain-wheel ss; then a peg or pin, about $\frac{1}{8}$ in. in diameter, is ewed into the chain-wheel boss, to enter a corres-nding hole in the back of the fixed cone, as Fig. 38 may be soldered on to the axle in the way already cribed. Fig. 39 represents partly in section the ished axle and cones of an Æolus Humber pattern tom bracket.

wo oil-holes will be necessary in the bottom bracket; h should be drilled as near the ball races as possible, ı ensure the oil reaching the balls, and in such ›sition that, when the bracket is in place on tl chine, the lubricators will be quite upright.

Now proceed to finish the cranks. If the latl ›ntres will admit it, bolt the crank to the face-pla ith the outside of the crank upon the plate, and bore tl

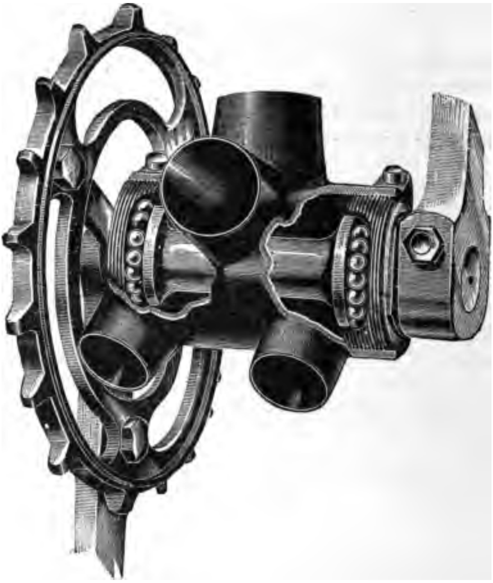


Fig. 39.—Humber Pattern Bottom Bracket.

ↄles to receive the axle with an ordinary boring tool ıe slide rest, or with a drill supported by the bac ›ntre. If the lathe-centres are too low to allow t 'ank to swing, fix a drill in a chuck and drill wi ıe face of the crank against a flat plate fixed in t ıck-centre. Care should be taken to obtain a smoo ↄle and a tight fit for the axle, which should be ifle large at first to admit of smoothing down to ıe crank-hole. It is a mistake to make this an easy ı hinking the key or cotter pin will tighten it up all ight; the only purpose served by a key or cotter pin s to prevent the crank from revolving on the axle, it will not tighten up a bad fit. File or mill out a slot in the pedal-pin to fit the pedals. If round cranks have been selected, centre and turn them to a gentle taper from end to end.

The method generally adopted of fixing the cranks to the axle will be seen by the illustration, Fig. 39. Keyed cranks are not now fitted so generally as they used to be, although, when well fitted, they are not likely to work loose. The detachable crank is readily fastened again by the cotter-pin should it come loose, whereas the keyed rank will require refitting. Should anything go wrong with the bracket, such as a ball breaking or cups cracking, it can be got at far more readily with the detachable rank. If the detachable crank is used, have the cotter-in parallel, and file the flat upon it tapering to fit a milarly tapering flat on the axle; a tapering cotter-pin tting into a semicircular hole on the axle is not satisfactory. Before putting the crank on the axle, see that he cotter-pin will knock right through its hole in the ank, otherwise the pin may bind in its hole before king a bearing on the flat of the axle, as it should do. ther methods of securing detachable cranks to an axle re illustrated by Figs. 40 and 41.

Proceed to bore and drill the lugs, etc., so as to get all he parts ready for putting together. Be careful to drill hem at the correct angle to suit their places; the correctess of these angles is essential to insure the frame tting together properly. The simplest method of boring he head lugs is to hold them in a three-jawed or four-wed chuck, the ball-race being outwards. Drill or ore the head lugs 1⅛ in. diam. to take the head tube, Fig. 42, and the cups also, or, if preferred, the castings ay be fitted to take the balls with no cups. When nished, case-harden the ball races with yellow prussiate f potash. Cool them by pouring on water with the hill off. Plunging into cold water would probably crack

the casting. The top and bottom head cones
turned and fitted now or left till later on. The
is drilled for the 1 in. down tube, for the ¾ in. fr
and for the ⅜ in. seat adjusting pin. A ⅜ in. c
hole must be drilled on the left-hand side of
and ⅜ in. tapping on the right side. All lugs sl
drilled so that the heads of the adjusting pins or
on the left-hand side, for this is more convenier
at than the right. Drill the back fork ends for r
the ¾ in. bottom back-stays and for receiving the

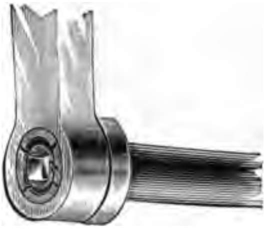


Fig. 40.—Crank Attached by Conical Screw.

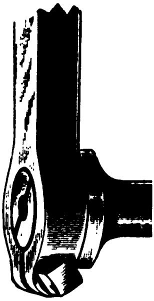
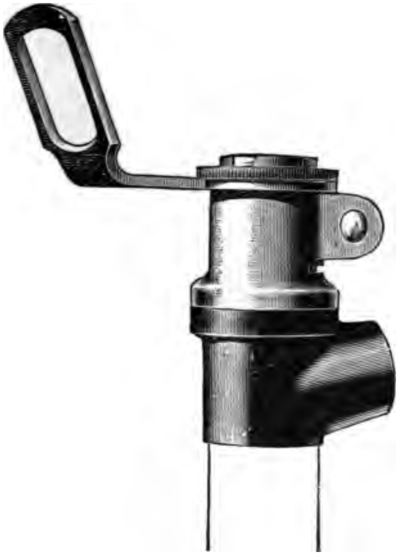


Fig. 41.—Crank
by Clamping S

back stay. File out slots in the back fork ends t
the back hub axle or the shoulders on the cones
ever is adopted, and fit the fork end chain adju
screw, as shown by Fig. 44. Drill the lamp-lug
adjusting cone to fit tightly the 1 in. steering-tut
42 gives an idea how this fits; case harden the l
only of this lug as described on p. 51, first seeing
the necessary work has been done to it, such as
for the ⅜ in. adjusting pin, slotting and fil
Drill and tap the brake work, including the
spoon to take a ⅜ in. brake lever; also drill
clearance hole at the fulcrum, and a ¼ in. tappin
end. In the brake adjustment casting, drill
clearance hole at the top, and a ⅜ in. clearance

ottom, and a ¼ in. tapping hole for the adjusting Drill the brake lever lug ready for brazing on andle bar with a ¼ in. clearance hole in the front and a ¼ in. tapping hole in the back. Drill and to a ¼ in. Whitworth thread the fork-end adjusts. Drill the fork crown to take a 1 in. steering and the ⅜ in. brake-rod and mud-guard screws.



. 42.—Ball Head with Lamp Bracket and Lug for Steering and Top Tubes.

r the steering-tube of front fork to fit the lock-nut; 26 threads to the inch will be a good for this. Do not screw the tube any further down is necessary to take the lock-nut and allow for its tment, as the cone and lamp-lug, having a plain will fit better on the plain tube than on the d screwed to take the lock-nut.

re should be taken to drill all holes to depths uniformly proportionate to their diameters, so that, knowing the depth of each hole, the tubes may be cut off exactly to length. A depth not less than the diameter will be satisfactory—that is, a tube of 1 in. diameter should enter its lug at least 1 in.

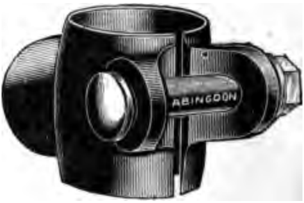


Fig. 43.—Split Lug for Seat Pin.

With the lugs all drilled, file or turn the tapering circular-ended lugs to a thin edge before fitting and brazing up—this will lessen any liability to nick the tubes when filing the lugs round the edges. Nicking

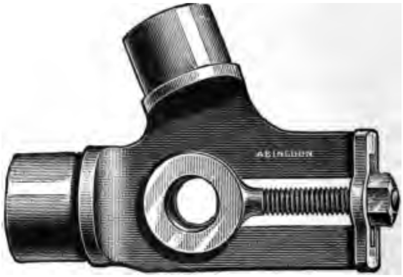


Fig. 44.—Back Fork End, with Chain Adjustment Screw.

st be very carefully avoided, for to file the tube und the lugs will fatally weaken the machine. N ling should be done after making up, excepting wha is necessary to clean the brazed joints; all thinnin down or shaping of the lugs must be done befor brazing.

Cut off the tubes exact to length, according to th rking drawing, making due allowance for the depth which they are to enter the lugs; a ¼ inch error this will entirely throw out the pitch of the frame and e angle of the lugs. Be careful in holding the tubes ilst cutting them off, for 20-gauge tubing will not nd rough usage in a vice. The wooden vice-block ig. 6) described on page 11, should be used.

In making up the front forks, drill the lower ends to atever size is necessary to fit the shoulders on the ont hub cones. Cut them off to allow 1¼ in. clearance etween the under side of the fork crown and the wheel ith the tyre on ; ¾ in. will be sufficient for a machine ith no brake. Pair the blades to see if both have xactly the same curve ; if necessary, correct by heating n the fire and carefully bending, taking care not to ink them in doing so. Fit the crown to the steering-ube, first having screwed it to receive the adjusting cone; raze the tube to the crown, set it true, and proceed to

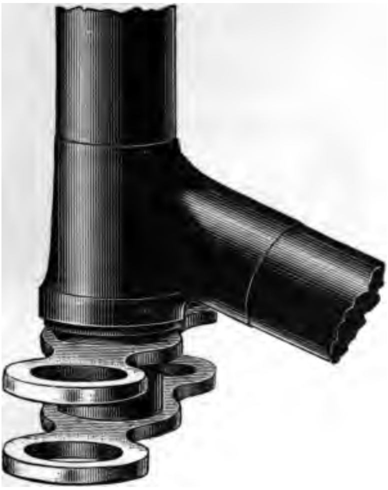


Fig. 45.—Fork Crown and Bottom Head Lug for Steering Tube.

fit the blades to the crown; put a small rivet or pegging screw into each side of the crown, to prevent the blades from shifting when brazing them. Take the front wheel spindle and cones from the hub (Fig. 46), put them into position between the blades. Screw the nuts on the spindle ends till tight against the fork ends so as to bring the forks the same distance apart that they will be when the wheel is quite finished and mounted. Before proceeding to braze, make sure that both blades are of *exactly* the same length; if so, and they have been carefully fitted, and they are brazed with the front hub spindle securely screwed between the forks, they should not require much setting after they are brazed.

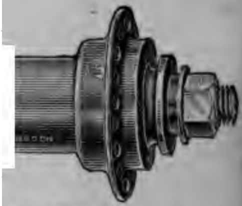


Fig. 46.—Hub for Front Wheel.

Braze the two forks to the crown, doing one at a time with the forks lying on their sides, and well supported, so that when red hot they will not bend of their own weight, and in such a position that the crown is lower than the hub end of the forks.

When the brazed joints are thoroughly cold (do not hasten the cooling with water or otherwise), remove the spindle and cones, and replace them in the hub, which should now be fixed in the forks with the loose or adjusting cone on the left-hand side. If the forks have been made up accurately, the wheel will be exactly in the centre of them—that is, there should be an equal space between each side of the rim and the right and left blades. If the space is not equal, set the forks by slightly increasing the curve of the blade on the side earest the rim, or by slightly straightening the curve n the side from which the rim is farthest. If a light bending will not bring the rim into the centre, ne blade is too long and must be unbrazed and hortened. When the wheel has been got quite central, est along the edge of the rim with a straight-edge, ointing it to the top of the steering-tube to see that he tube is true with the wheel and forks; if not, hold he steering-tube in the vice with the wheel in place, and straighten by pulling it bodily over from the side to which it leans. This straightening may be done cold without fear of damage; if the wheel is securely fixed in the forks, they will not get twisted out of truth whilst setting the steering-tube.

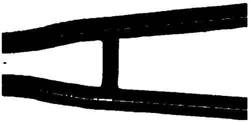


Fig. 47.—Back Stays.

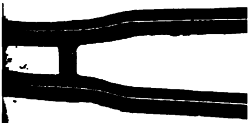


Fig. 48.—Chain Stays, with Slotted Ends.

Whilst at the fire form the flats on top of the ack-stays through which the ⅜ in. pin will pass to ecure them to the seat lug. Drill a hole to tightly t the ⅜ in. pin, or the back wheel may get out of entre should the pin or locking-nut become loose at ny time. The bottom ends of the back-stays may be lotted as shown at Fig. 48.

When the front forks have been built and set, and all the lugs drilled to sizes and angles suitable to receive th tubes intended to enter them, the frame can be pu together. Upon the accuracy with which the back par of the frame is put together will depend the free an easy running of the finished machine. It must be buil so that the crank axle chain-wheel is dead true with th chain-wheel on the driving hub, and care must be take to get the head equally true.

Have ready all the tubes cut to the exact length according to the working drawing. With a strip o emery cloth clean the ends of every tube for about 2 in where they enter the lugs, holding them with the woode vice-blocks described on p. 11. If not already don drill and tap the holes in the bottom bracket to receiv lubricators; fit these, and remove them again till aft the machine is finished and enamelled, when they ma be finally screwed in. Fit the bottom back-stays int the fork ends, holding the fork end in the vice an driving the tube into it with a wooden mallet till su that it is well home to the bottom of the hole. The joints can now be brazed. No pegging screw or riv will be required if the tubes fit tight. Fit the top an bottom head lugs to the 1⅛ in. head tube, knocking the on with the mallet; take care that they are at th exact distance apart to suit the front fork tube and th cones for the ball-head. It will be well to slip the fro fork into the head with the cones and balls all in, make sure everything is exact. Remove the fork an correct any mistake. Fit the top and bottom fro

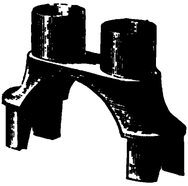


Fig. 49.—Strut Bridge for Chain Stays.

s into the head lugs, put a screw or rivet into the

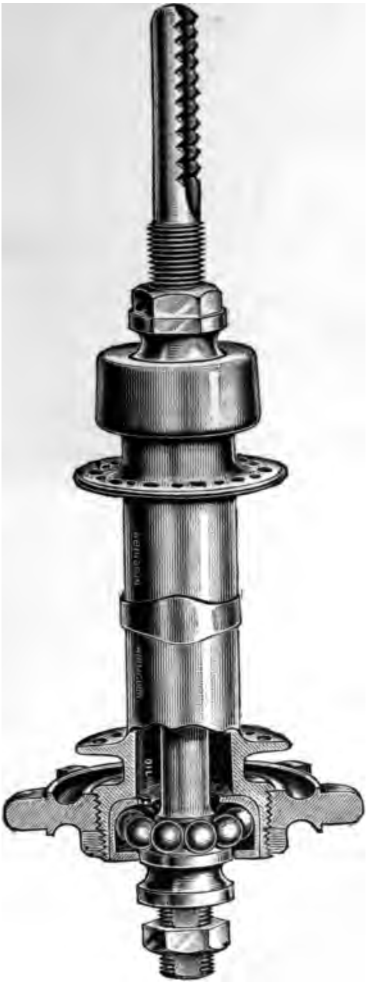


Fig. 50.—Hub for Back Wheel.

bottom lug to prevent it shifting on the he and set the top and bottom tubes so th axes are in the same plane. Fix the top the head tube, in the same way as the bot is fixed, by a screw or rivet, to prevent it out of plane with the bottom and shifting directions whilst brazing. The top and bottom they fit tight, will not require to be pegged or ri their head lugs; but, if loose, a peg may with a be put in them. Before brazing, remove the there are any, from the head, or they will get by the heat.

Fit the down tube between the bottom bra seat-lug, pegging both ends of the tube to shifting. To make these two lugs perfectly t each other, knock the top and bottom fron which have been fitted and brazed to the he porarily, into them whilst being pegged. Ren ends of the top and bottom front tubes and to braze the bracket and the seat-lug to the do The bottom bracket must be exactly at right an the down tube. If upon trial it is found not t heat the tube just above where it is brazed into grip the tube in the vice, put a rod through the and pull it square. Before fitting any more tub lugs, roughly file them up, as they are easy to ge but when the whole of the frame is together, be rather awkward. Proceed to fit the botto stays to the bracket, taking great care that both of equal length. With a gauge made of a spoke wire, Fig. 19, page 24, measure from the of the fork-end slot to the bracket. When m make sure that they are both knocked right the lugs, if one is longer than the other make equal length. Set the fork ends so that, bo they are perfectly parallel with each other on and see that the slots also are parallel.

Screw the back-wheel spindle (Fig. 50) in it position in the fork ends to ensure their bein act distance apart; then peg the bottom back-stays to e bracket and braze the joints. Allow them to oroughly cool before removing the spindle. Fit the p back-stays to the fork ends; they must both be t *exactly* the same length, for if one is $\frac{1}{32}$ in. longer han the other it will throw the wheel out of centre. ut the $\frac{3}{8}$-in. seat adjusting pin through the holes in e top of the stays, and screw them up tightly to the at-lug. Slip the wheel between the fork ends and ew up so that the rim is exactly central between both e bottom back-stays and the top back-stays. If the heel does not come midway between the top back- ys, it shows that :—(*a*) One back-stay is longer than e other; (*b*) the slots in the fork ends are not cut tly to the same depth; or (*c*) one stay has shifted ilst putting the wheel in. Rectify the error before gging up, which should be done with the wheel in ce; then put a peg into each back-stay to secure the k ends whilst brazing.

When this part is satisfactorily fixed, remove the eel, braze the top back-stays to the fork ends, and ow the work to cool. Slip the cups in to the bottom cket, put in the chain-wheel, the axle, and the balls, place the wheel, and see that neither joint has shifted brazing. Set the wheel exactly central between the p and bottom back-stays, and, with a steel straight- ge, test whether the two chain-wheels are in line. not, remove the wheel, and pull the back-stays, one a time, towards the side required, until the chain- eels are in line to within $\frac{1}{32}$ of an inch. Try the aight-edge on several places, as the chain-wheel is ble to be slightly out of truth sideways; or it may be py in places, which would throw out the measure- nts. When the chain wheels have been got satisfac- ily into line, remove the wheel and cups from the cket, and fit and peg the front part—consisting the head with the top and bottom front tubes ached to it—into the front holes on the bottom cket and seat lug. Lay the frame on the full-sized drawing to see that the rake of the steering tul lengths of top and bottom front tubes are e: the head tube so that it is in the same pla down tubes, and braze the joints.

In building the back part of the fran frequently have to be applied to the full-sized When the bottom back-stays have been fitt bottom bracket, test to see that the down tu the proper angle with them. When the bac brazed and set, test and make sure that the bottom front tubes are of the proper length. V are fitted to the back part, the exact angle of th tube is got by laying the frame with th bracket and back fork end in position on the a straight-edge placed along the front of the show whether it is parallel with the rake line one of the front tubes will want shortening. · 1 should, of course, be tried before being pegged

The cups, if any, in the bottom bracket in the head may be finally fixed in their pl but if the frame is to be stoved at a high ture, it will be best to take out the cups w machine is being enamelled, for they may get s the stove by the heat. In either case, with en thoroughly clean out the hollows in the bracke outsides of the cups, making the surfaces quite order that they may take the solder well. Th applied by holding the cups with a pair of tongs in the flame of a Bunsen burner, and tin tinman's solder, using a solution of zinc chlc flux. The inside of the bracket, to receive should be tinned in the same manner, and b then reheated sufficiently to melt the solder, are pressed or knocked right home, and the wh immediately in water. Sometimes the cups a pressed in without soldering, but the resu satisfactory.

A tube that has a tightly-fitting lug at l should have a hole drilled through it for the when heated in brazing, otherwise the tube may rst or tear away from its lug. A hole $\frac{1}{16}$ in. diam. ill do, and it should be drilled in such a position as be out of sight, and where it will tend least to weaken e tube. Tubes with open ends will not require air oles, nor will those, such as the down tube and front ttom tube, which have a hole drilled through into the acket.

In setting the back part of the frame to track properly, d the head to be perfectly upright with the rear wheel, st fix the front wheel between the forks, which have eady been set as described on page 56, and adjust them the head, with cones and balls in position. Fix the ck wheel in the frame, taking care to have it exactly ntral between the top and bottom back-stays. With long wooden straight-edge try if the wheels track operly: to do this, turn the machine upside down, d hold the straight-edge firmly against the edge of rim of the rear wheel, testing it at several places d on both sides. If the straight-edge should be off left side of the front rim, with the blowpipe heat front bottom tube as near the bracket as possible, d quickly lay the machine on its right side. Get eone to stand on the top head lug, and then place foot on the bottom bracket, and press sufficiently bring the front true.

When this is set so that both rims are perfectly true n the machine right way up, and proceed to set the . If the straight-edge is off the left side of the front k tube heat the top front tube as near to the seat-lug possible, lay the machine on its right side, and, with assistant standing on the centre of the front wheel ndle, place one foot on the seat-lug and press it till other part is brought true. These operations must done rapidly, for the thin tube soon cools.

To make a lap-joint in the steering tube for the ndle-bar saw a slit about $1\frac{1}{8}$ in. deep in one end; t the tube and hold it lightly but firmly in the e; open out with a solid rod about $\frac{1}{2}$ in. diam. and finish with one the size of the handle-bar—nam diam. Place the handle-bar in the joint, wit held in the vice, and, with a light hammer, beat tightly on the handle-bar, the two ends just me top. Hold the joint tightly with a hand vice each side, drill and tap a hole to receive a peggi to prevent the parts shifting in brazing, and to joint close. Load the T with brass and borax, a with the T tube upright. Do not let it stay on longer than necessary to get the brass to run. cool, see that the T is square with the handl not, heat it close to the joint, and set it square.

Fit and fix the brake lever-joint, and br the handle-bar; after brazing, clean the joint ar brake-lever; see that it works freely, yet witho or play, that the lever follows the sweep of the bar, and that there is sufficient movement to apply the brake. If the forks have been cut off the proper amount of clearance, the extreme ha of the lever should work about 3 in. There ar kinds of break-adjustment; Figs. 113 and 114 s either of which may be adopted with equal succ 113 will require about 1 ft. of ⅜-in. Bessemer steel a malleable casting, as shown, for the adjustme will be more simple and cheaper to make than which is lighter and neater. It will require a of ⅜-in. diam. 18 B.W.G. tube, a ¼-in. plunger-ro nicely to fit the tube, and a small split-lug b fitted loosely to the ⅜-in. tube for gripping the rod. Braze the brake rod or tube to the brake-sp set square. See that the rod works freely but shake, in the ⅜-in. hole in the crown-lug, that it is parallel with the front fork-tube. the brake off the wheel when released, a spring required. A simple and effective form is th fitted on over the brake-rod or tube between through which it passes, and a small lug-collar fixed on the rod or tube at a suitable distance.

The seat or ┐ pin may be made from one

B.W.G. tube, ⅞-in. diam. about 11 in. long (as Fig. 51), from two pieces joined with a lap-joint (as Fig. 52). he latter, having a sharper bend, admits of greater justment of the saddle over the down tube. Fig. 51 ould be bent with a corner as sharp as possible, d not with a wide curve, which looks clumsy, and mits of little adjustment. The ˥-pin may, if pre-red, be made with a straight piece of 14 B.W.G. tube, d about 6 in. of ⅝-in. Bessemer rod for the top; but solid rod makes the ˥-piece heavier, and has no vantages over those illustrated. The strength of ˥-pin will depend on the gauge of the tube used.

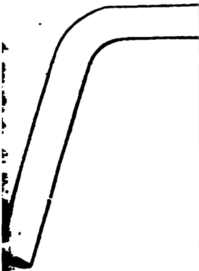


Fig. 51.—Seat Pillar in One Piece.

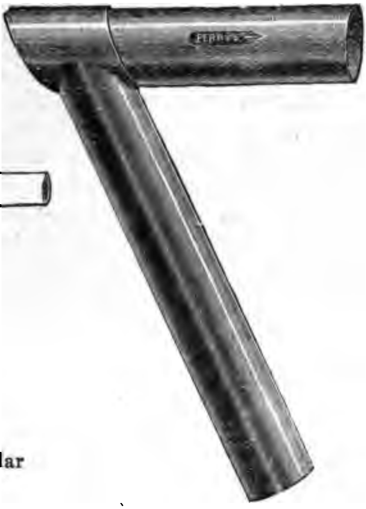


Fig. 52.—Seat Pillar Jointed.

Drill the mud-guard bridges to receive the screws h which to fix the mud-guard, and file the bridges to fit the radius of the mud-guard. Fit and braze mud-guard bridges to the frame, 15¼ in. from the tre of the fork-end slot. Make the stays for the

front and back-guards, from Bessemer steel, $\frac{3}{16}$ in. ro
or $\frac{3}{8}$ in. by $\frac{1}{8}$ in. flat; forge the eyes to fit the
spindles. These stays should measure 15¼ in. from
centre of eyes to the angle of the bend. In forming
eyes, bend them as Fig. 53, so that screwing the
tight against the eye has a tendency to keep it cl
If turned as Fig. 54, screwing the nut against it
cause it to open. The stays should be fixed about
from the ends of the mud-guards. Drill two rivet-l
in each stay and fix the mud-guards to them eithe
copper rivets, or by brazing them on. With the
fixed in their places, mark off holes for fixing the gu

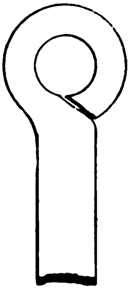


Fig. 53.—Correct Form of Eye for Mudguard Stays.

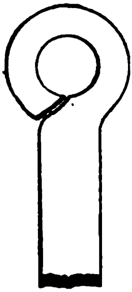


Fig. 54.—Incorrect Fo
Eye for Mudguard St

to the bridges, thus: Hold the back frame in the
and slip the mud-guard in its place with the wheel i
the stay eyes on the spindle. See that the guard c
the rim of the wheel equally on both sides, and that
sides of the stays are of equal length; then scrib
holes through the bottom and the top bridges, re
the mud-guard from the frame, and drill or punc
the holes accurately to the scriber marks. Treat
front guard in the same manner when the whe
between the fork.

With a hack-saw cut a slot, from $\frac{1}{16}$ to
wide, in the steering-tube and the down tube of

back frame for the adjustment of the handle-bar and the ┐-pin. Saw a slot not less than 1¼ in. deep, or they will not grip properly.

The machine may now be filed up bright, ready for enamelling, particular care being taken not to nick the tubes round the edges of the lugs in the process, more especially round the edges of the top and bottom head-lugs and the front-lug on the bottom bracket, as these tubes receive the most strain in riding. In filing up the handle-bar, be careful round the edges of the T oint. When the joints have been rough-filed and mooth-filed, use strips of No. 2 emery-cloth about ½ in. ide to get out all the file marks, and polish the tubes engthways with larger pieces of emery-cloth. The etter the polish is on the frame the higher will be he finish after enamelling; for though the enamel may e ever so good and well done, unless the surfaces of he tubes and lugs are first well finished, it will lack he high finish of best work.

When every part so far fitted is filed up and polished, ut the whole together ready for riding, and ride the achine for some ten or twenty miles. This will show hether everything is as it should be. The drop of the andle-bar, or the pitch or angle of the ┐-pin, may not it requirements. Or the frame may have been ained so that the wheels do not track accurately. good plan is to ride at a quick pace, as straight as ossible, over ground that will clearly show the wheel-arks: on examination there should be a mark as of only e wheel; should there be the least appearance of two acks or wheel-marks, the machine is out of truth, and ust be re-set as described previously. This may be ne now without fear of spoiling the enamel or the ting.

When the parts have been enamelled they must cleaned and prepared for finally fitting the machi gether. Clean out the hole in the front fork for the ake-spoon and fork-end, fit the brake-spoon and ring, see that the head lock-nut works freely on its thread, fit the mud-guard, and lastly place the wh in position, with the loose or adjusting cone on t left-hand side of the fork.

Take the back-frame and clean out any enam from the bracket-cups, ball-head, fork-ends, and scre holes; screw in the lubricators for the bottom brack and put the seat adjusting screw in its place. Get rea the crank chain-wheel and axle by fixing the tight con fit the crank on the chain-wheel side of the axle; th the other crank, care being taken that the two cran are perfectly square with the axle and with each oth Mark or number the cotter-pins and crank, so as show which way they were fitted, and remove the c crank to try on the loose cone, lock-nut, and D-wash Scrape off any enamel which may be lodged in the tee of the chain-wheel, and which would interfere with t running of the chain. With the frame lying on its si place the axle in its bracket with the right number balls, and then turn over to put the balls and cone in the other side. Adjust the cones carefully, so that t wheel revolves freely, yet without unnecessary pl anywhere. If this cannot be done, either the balls a of unequal size, or the cups are not fixed truly one the other, or one or both cones are not perfectly tr Find what is the fault, correct it, and then refit t crank. Fix the mud-guard in position, and, with the a justing cone on the left, adjust the back wheel in pla see that it runs freely, yet without unnecessary pl Put on the chain, adjusting it so that it will sag sligh with its own weight. Screw up the fork-end adju ments securely, so that the wheel is exactly cent between the top and bottom back-stays.

The front fork may now be adjusted in its place the head, the lamp-bracket and ball-head lock-nut c be fitted, and the handle-bar (with brake-lever a handles previously fitted) can be finally fixed in pl and set square with the front wheel. Fit the ┐-pin place, and adjust everything ready for the saddle a pedals.

The machine will now be practically finished, **ready or pouch** and lamp; after an oil up all round, and **a eneral** tightening of nuts and screws, it will be **ready or the road**

CHAPTER IV.

BUILDING TANDEM SAFETIES.

WORKING drawings for a Tandem Safety are represe by Figs. 55 and 56. The wheels should each be 28 the back one having 36 spokes, 15 B.W.G., butte B.W.G., the front one 32 spokes, 15 B.W.G., butted B.W.G., or 13 B.W.G., plain. The hubs for a machin this class should be strong, the front spindle not than $\frac{5}{16}$ in. in diameter, and the back spindle not than $\frac{3}{8}$ in. in diameter, with an eight-toothed chain w on the driving hub.

The frame illustrated is simple, and strong en to carry 22 to 24 stone. It may be strengthe however, by fitting a tube of 1 in. diameter an B.W.G. from the front seat lug to the rear bot bracket.

The diameter and gauges of tubes should be follows :—(A) $1\frac{1}{8}$ in. by 20 B.W.G. ; (B) 1 in. by 18 B. (C) $\frac{7}{8}$ in. by 20 B.W.G. ; (D) 1 in. by 20 B.W.G. ; (E) by 20 B.W.G. ; (F) $\frac{7}{8}$ in. by 18 B.W.G. ; (G) 1 in. b B.W.G. ; (H) $\frac{5}{8}$ in. by 20 B.W.G. ; (I) $\frac{3}{4}$ in. by 18 B.W (J) $1\frac{1}{8}$ in. by 20 B.W.G. The front fork tube, 1 in. b B.W.G. ; handle-bars, $\frac{7}{8}$ in. by 18 B.W.G. ; handle-bar $\frac{7}{8}$ in. by 18 B.W.G. ; front forks, at least $1\frac{1}{8}$ in. wid top by 18 B.W.G. If the steering is required t connected, it may be accomplished by a tube, $\frac{5}{8}$ in 20 B.W.G., connecting the right-hand handles at t extremities, and working on a hinge-joint at handle-end.

For the wheels it is necessary to remember the e load a machine of this description has to carry, an provide for it. The hubs ordinarily used for a driver, with $\frac{3}{8}$ in. back and $\frac{5}{16}$ in. front spindles, wil for the wheels of a tandem machine, if the weight t carried is not too great—say, from 20 to 21 stone;

t will be safer for this weight, and absolutely necessary or a greater, to use a $\frac{7}{16}$ in. back and a $\frac{5}{16}$ in. or even in. front spindle, with $\frac{5}{16}$ in. balls for the back and in. for the front hubs. This will make the hubs rather large, but will avoid the trouble and annoyance

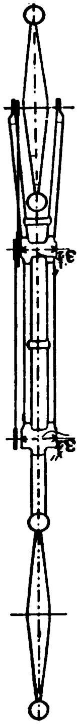


Fig. 55.—Plan of Tandem Safety.

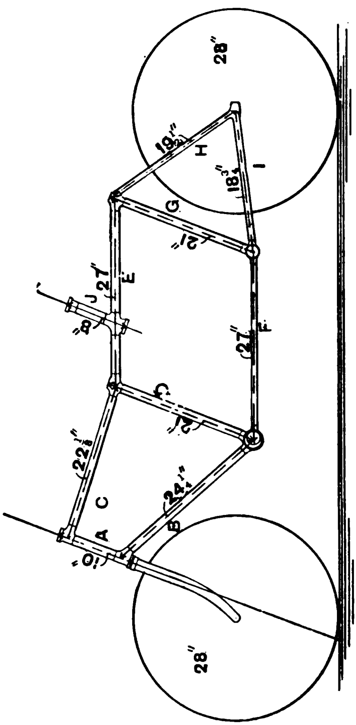


Fig. 56.—Elevation of Tandem Safety.

of balls and cups cracking and grinding up. The c of both front and back hubs should have a shou in. larger in diameter than the spindles, to take bearing in their respective fork ends. This will reli the spindles of a deal of strain, and they will the be less liable to bend. The rims should be o roadster section, and the wheels carefully trued- an even spoke tension is got, especially at th wheel where there is an enormous stress at th end of the spokes. If tangent hubs and spokes ar solder the spokes to the hub flanges after the whe finally trued up.

A full-sized working drawing should be mad board, or, if nothing better is available, on the floor of workshop. In setting out, having first the base line, strike out the back wheel with a radius. Mark off the centre of the rear crank 18¾ in. from the centre of the wheel, and 12 in the base line; then mark off and connect all th and centres according to dimensions given in F which, it will be noticed, are taken from the axes tubes at their junctions. Thus: the front botto B is marked 24¼ in.; this is from the centre front crank spindle to the axis of the head The axes of the down tubes D and G are 21 in the centre of crank spindles to the extreme top seat lugs. A full-sized drawing of the botto should also be made as Fig. 55; this will ena builder to obtain correct measurements for the axles, the distance of the chain wheels from eac on the rear bottom axle, and the correct chain li very important matter to ensure the easy an running of the chains on the chain wheels. The line is the centre line of the chain and chain teeth, measured from the dotted line running thro centre of the machine in Fig. 55. Thus if the d from the centre line to the centre of the chain teeth on the driving wheel being say 2 in., the d from the centre line to the centre of the te the large chain wheel on the rear bottom brack must also be 2 in. The small wheel on the rear b axle must be the same distance from the centre is the chain wheel on the front bracket axle. T too much importance cannot be attached; accu absolutely necessary.

n building the frame start from the rear fork ends, set each part true before adding the next, otherwise t difficulty will be experienced at the finish. Fit fix tubes H and I to the rear fork ends, and braze n there; between these place the wheel and set them with the rim of the wheel. Fit and fix the rear ket and the rear seat lug to the rear down tube G, fit fix the fork end tubes to these, and braze the joints. his part true with the wheel, then take the head tube d to it fit and fix the top and bottom head lugs; nd fix to these lugs, tubes B and C, and braze these

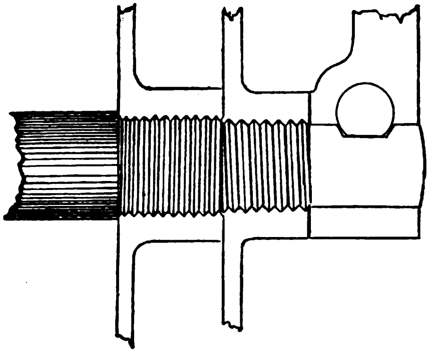


Fig. 57.—Method of Fixing Bracket Chain Wheels.

Fit and fix the front bracket and front seat lug he front down tube D; braze and set tubes B and C ect in angle with the head tube A, and get the tubes , and C all in one plane. Next fit and fix tubes B C to the front bracket and front seat lug, and braze Fit, fix, and braze the top head lug to the rear l tube J, and the tubes E and J to the bottom head The front and rear portions of the frame will then eady to be connected by the stays F and the T tube E. t see that the parts already brazed have set truly. n fit, fix, and braze the tubes E and F to the front ket and front seat lug, first making sure that the t and the rear heads are quite parallel.

Before making the final joints at the rea
and rear seat lug, see that the tubes E and F a
correct length to bring the frame together at
angle, according to the drawing. If the bott
F are too long, too much rake will be given to

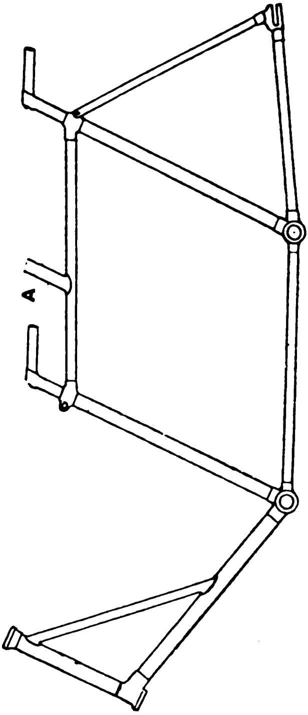


Fig. 58.—Design for Tandem Safety Frame.

forks ; if they are too short, the forks wil
upright ; either defect will spoil the shap
frame. With these final frame-joints fitted a
roceed to braze them. Great care must be
pport the frame whilst being brazed in such
t these joints will be quite free from any str

The bottom brackets here shown are the best kind for this class of machine. The rear bracket is of the ordinary barrel pattern: the front bracket is of larger diameter, and has an interior portion containing the bearings, and these can be turned on eccentrics to obtain the right adjustment of the front chain. This form of adjustment is the best for the front chain of a tandem, as it gives a practically rigid bracket and a perfect adjustment of chain. Swinging or sliding brackets are not to be recommended, for they are much more likely to work loose, and are seldom quite rigid. The width of the brackets should not be more than 3½ in. over all. The rear chain is adjusted in the ordinary manner at the fork ends; but here, again, a little additional strength is required. The adjustment screw should not be less than ¼ in. in diameter. The rear chain should be of extra strength, and of the best make, and not less than ⅜ in. wide; the front chain, however, need be only $\frac{5}{16}$ in., or ¼ in. in width on a light machine.

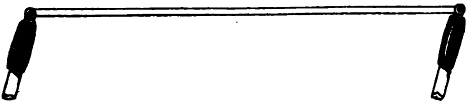


Fig. 59.—Steering for Tandem Safety.

The front forks and crown require extra strength. The crown must be strong, and the forks not less than 18 B.W.G. and 1¼ in. wide. The front fork tube should have a strengthening piece brazed inside it for about 4 in. from the crown. Some of the best machines have come to grief over their tandem forks and crowns through the use of exactly the same patterns as those put into the ordinary rear driver.

A satisfactory method of fixing the rear chain wheels to the axle is shown at Fig. 57. The wheel connecting the hub chain is first screwed on with a left-hand thread, and then the wheel connecting the front bracket with a right-hand thread. If the crank is fitted so that the action of the driving cotter-pin draws the face of the crank boss against the chain-wheel boss, no nut will be necessary; but unless this is thorou well fitted, a locking nut will be required, screwin with a left-hand thread. The rear bracket axle sh be stronger than in the case of a geared ordinary.

The tandem safety frame illustrated in Fig. 5 intended to carry eight stone in front and ten s behind. The steering may be connected from the of each handle, as shown in Fig. 59—the tube to be by 20 B.W.G., placed on the right-hand side of machine. Make the rear bracket a fixture; shif brackets should be avoided as much as possible. fixing the chains, put them both on the right hand The front chain may be lighter than the back. vision must be made in the socket tube A, Fig. for the handle-bar T to turn freely, and for the adj ment of the handle-bar. Fig. 58 is a simple strong frame, and possesses the advantage of allowi lady rider's dress to fall further over her foot when pedal descends.

The diameters and gauges of the tubes will as follows: for the tube from the head to the f bracket 1¼ in. diam. by 16 B.W.G., and the stay f the top of the head to the front tube ¾ in. diam 20 B.W.G. The front seat should be built 2 in. lc than the back seat, to better enable the rear ride see over the front rider's shoulder.

CHAPTER V.

BUILDING FRONT-DRIVER TRICYCLE.

HE child's tricycle usually on sale is a crude affair, ade with a frame of solid galvanised iron. In the ricycle here described the frame is tubular, though it ay be made from solid iron at the option of the maker. f the rear wheels are 18 in., the front wheel, which is e driver, should be 24 in.: all with ⅝-in. crescent rims r solid tyres. The front wheel A (Fig. 60) has a hub ith a fixed axle, exactly as in an "ordinary" bicycle. he axle is of ⅝ in. steel, long enough to pass through e bearings in the fork ends, and to take the cranks, hich are keyed on. The rear wheels B are 18 in. in meter, and run free on the axle C, which is a fixture the ends of the semicircular part of D (Fig. 61). The nt wheel thus becomes both steerer and driver; it ns in a fork which may be solid or hollow, at option. his fork has six inches of ¾-in. tube ascending from crown, the top of which is fitted with a lug having a t screw (see Fig. 62). The handle-bar stem is about in. long, ⅝ in. thick, and solid. The set screw in the p of the crown tubes fixes it and the handle-bar ether.

The malleable socket D, in which the front fork, with wheel, turns, is made to admit the ¾-in. crown tube ove mentioned (Fig. 63). It receives the backbone and through the almost vertical eye 4½ in. of ⅞-in. tube fitted, and brazed at the same time as the backbone. g. 63 shows the casting with the tube in place. On the per end of the backbone tube, a small ring is fitted; affords a rest for a spiral spring, which is placed on inner tube, between this ring and the lug (Fig. 62). e lower ends of the forks have plain steel or gun-metal rings, each bolted on with one bolt. In Fig. 64, A represents a face and B an edge view; the beari measures ¾ in. through the hole. The cranks have a thro of 4½ in. The solid handle bar, 18 in. long by ½ in., i straight till it reaches the handles, when a slight tur is made, as shown by Fig. 61. The frame has malleab castings at C, D, and E. The backbone E (Fig. 60) is 1 in. tube. The tube C, D, E is ¾ in. diam. The bac axle is of steel, 26 in. long, ⅝ in. diam., and is curved a 6 in. radius, the parts that receive the hubs bei reduced to ½ in., and nuts are fitted on the ends. T

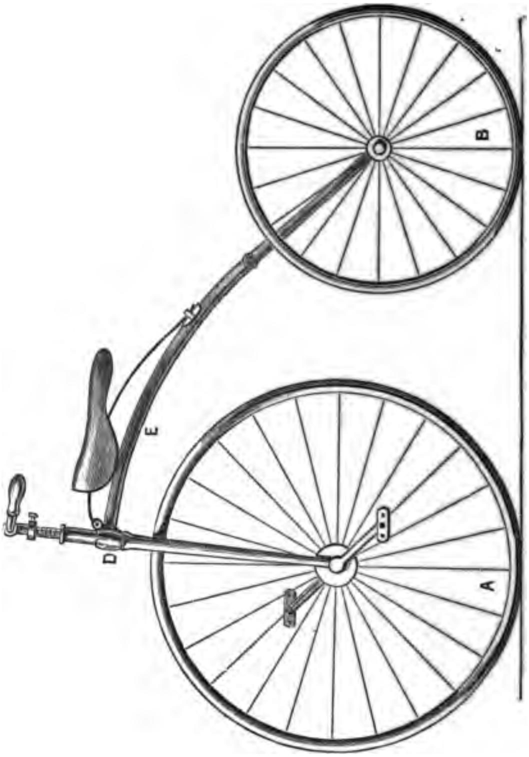


Fig. 60.—Elevation of Child's Tricycle.

heels must run freely on this axle. The centre lug D ig. 61) is bored with a $\frac{3}{4}$ in. hole to receive the tube D, E, and its other end forms a tenon, as shown by ig. 65, that enters the lower end of the backbone.

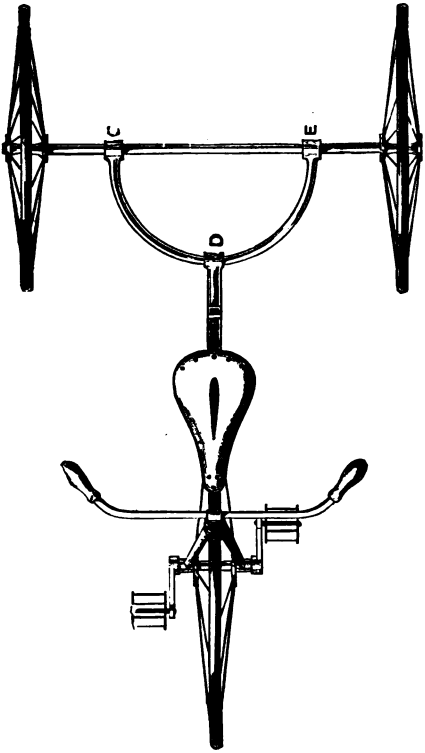


Fig. 61.—Plan of Child's Tricycle.

he two lugs C and E are like Fig. 65; the ho
hem receive the $\frac{5}{8}$ in. axle, and the tenons enter the nds of the $\frac{3}{4}$ in. tube. The lugs C and E are fixed to he spindle, 12 in. apart, by two small pinching screws.

The machine is shown without either brake-work or

mud-guard, as these are not usually fitted to this c
of tricycle. The saddle, as will be seen by Fig.
rests upon a spring of the "ordinary" bicycle form.

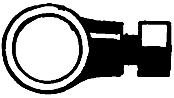


Fig. 62.—Steering Tube Lug.

the upper side of the neck lug casting (see Fig. 63) a s
lug is provided; to this the forward end of the sp
is bolted; the rear end is allowed to slide in a bri

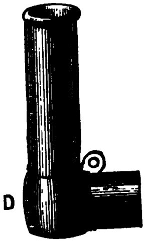


Fig. 63.—Front Casting and Tube.

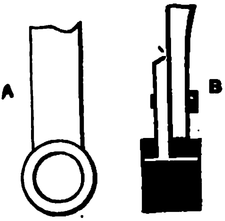


Fig. 64.—Front Wheel Bearin
for Child's Tricycle.

piece (Fig. 66), fixed on the backbone by two sm
screws.

Assuming that the wheels are ready to hand, t

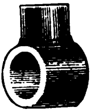


Fig. 65.—Lug for Rear Axle.

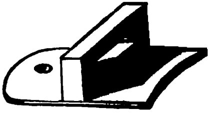


Fig. 66.—Slide for Spring.

front forks, 13 in. long, may be brazed into a li
crown, provided with two tenons to receive them,
with a round tenon on the top to receive the in
steering tube. The lower ends of the forks are flatt

npression in a vice, and bored to receive the bear-
Fig. 64, *a*, *b*). The forks must be so set that the
oles in the bearings will be in line with each other
eive the spindle. The various lugs have the holes
em bored to exactly fit the outside of the tubes
re brazed into them, or the tenons on them are
d down to the exact inside size of the tubes.
e joints, before being brazed, are pinned to pre-
shifting when they are being heated. The handle-
tem and T piece are formed in one casting; the
is turned to fit inside the inner steering column,
he T is bored to receive the ½ in. bar. It is then
d, and when cold some 3 in. at the ends are bent
m the handles, as shown. It may be mentioned
this machine, though it has three wheels, is not so
or a child as a two-wheel safety would be.

CHAPTER VI.

BUILDING A HAND TRICYCLE.

The illustrations show a hand tricycle of simple fo
Fig. 67 is a side elevation of the machine, with t
wheels outlined only; Fig. 68 is a plan showing t
frame, crank-shaft, footboard, steering-bar, etc., t
wheels and driving levers being omitted. The drivi
wheels are 30 in., and the trailing wheel, which is al
the steerer, 16 in. in diameter.

The frame is of the loop order, with a central bac
bone running rearwards to the steering wheel. T
driving axle is double cranked, with both cranks on o
side as shown by Fig. 68. The driving levers
attached to the cranks by suitable grips, or bearin
In the act of propulsion both levers are moved forwa
and backwards together, and the propelling force is th
applied equally in the forward and backward strokes
the levers.

A seat on springs is shown, for a saddle is sel
found suitable for a cripple's use. The for
ends of the frame carry a wooden footboard, u
which is a small wheel which rests on the ground w
mounting the machine. The steering is effected b
pad, or cushion, P, situated between the knees of
rider, and connected to the steering rod, which pa
under the seat to the steering wheel behind.

The 30-in. wheels have hubs with ¾-in. holes thro
them to receive the axle. One wheel is firmly keye
the axle, the other runs free. The axle A made f
⅞-in. round steel bar, is 36 in. long over all. The
cranks C, C are 20 in. apart, from centre to centre,
have a throw of 2 in.; thus the stroke is 4 in. at
cranks.

The diameter of the axle is reduced to ¾ in. at s to receive the wheel hubs, and the extreme ends

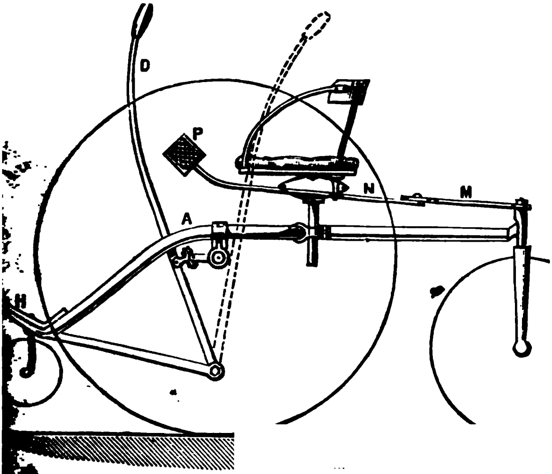


Fig. 67.—Elevation of a Hand Tricycle.

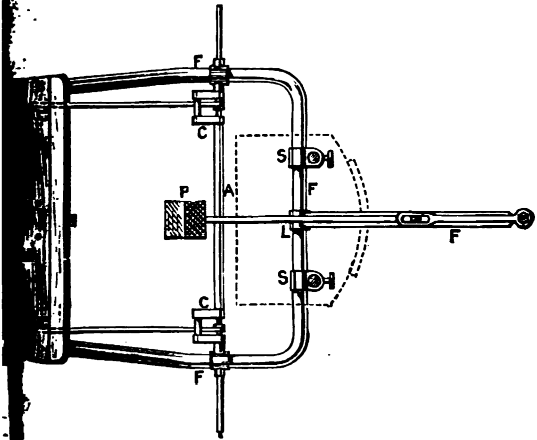


Fig. 68.—Plan of a Hand Tricycle.

further reduced and screwed for ⅜-in. nuts, which keep the wheels on. The driving axle is carr bearings, situated immediately under the frame s little behind the bend at A, Fig. 67. The knuckle-j bearings are carried in small forked lugs brazed frame to hang downwards, as shown in Fig. 69.

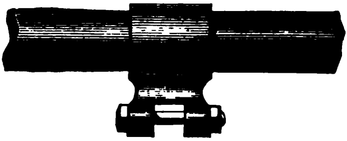


Fig. 69.—Lug for Knuckle-joint Bearing.

The frame F is made from steel tube, 1¼ in. B.W.G. One piece makes the loop, which is bent to f parallel-sided frame, 26 in. across, outside measure The forward ends are bent downwards and in and then for about 6 in. they are flattened and t upwards to carry the footboard H; 6 ft. 6 in. of would be wanted to make the loop-frame, and for the backbone. The backbone is attached t centre of the loop-frame by a strong bracket or and, 6 in. to right and left of this lug, are two lu

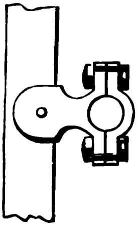


Fig. 70.—Grip Bearing for Hand Levers.

Fig. 68, with ⅝-in. vertical holes to receive two pins; these are held in place by two pinching scre

The rear end of the backbone has a neck wh pivoted into the fork head, known as the Stanley The two driving levers D are 2 ft. 10 in. long, and

dles at the top ends. They are pivoted at their lowei
s to a swinging frame, the forward ends of which are
ged under the footboard H in front. The two grips
ch attach the levers to the cranks are shown by
. 70. They are made of two parts like a plumber
ck, and may have either plain or ball bearings. They
brazed to the levers at a point 10 in. above the
rum, or lower end. The levers are made from 1¼-in.

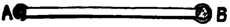


Fig. 71.—Side Bar of Swing Frame.

⅜ in. steel; they may be reduced to 1 in. by ¼ in. at
, but they must be strong at those places where the
s are attached. The upper ends are slightly curved
ards the rider. The full stroke of the levers at
handles in this arrangement is about 15 in.

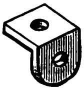


Fig. 72.—Hinging Bracket for Swing Frame.

The swing frame consists of two side bars made from
1. by ¼-in. iron, of the form shown in Fig. 71; the
1. hole A hinges at the back of the footboard; the
1. holes B receive a long bolt, which forms the fulcrum

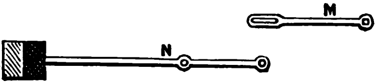


Fig. 73.—Steering Bar for Hand Tricycle.

the lower ends of the hand levers, which are
ed with ½-in. holes to fit the bolt. The levers v
their places on the bolt are close against the insia
side bars. The central part of the long bolt
re a piece of ⅝-in. tube slipped over it, and this w
p the levers in their places against the side bars. T

forward ends of the swing frame are each hing a bolt and nut to a small L bracket (Fig. 72), to the lower edge of the footboard. The footbo of wood, and has a ledge 3 in. broad, nailed to its edge to keep the feet of the rider from slipping wards.

The upper side of the steering bar is shown cor in Fig. 73. It is 27 in. long from the top of th to the back of the knee pad, and is in two parts. part M is bolted fast to the top of the fork head, ar in line with the backbone when the wheel is s running straight ahead. It has a square hole a rear end and a 3-in. by ½-in. slot at the front end distance from the square hole to the centre of the 9 in. The part N is 18 in. long ; its rear end is flat and has a ½-in. pin fitting into the slot in M. The n of the length of N is thickened, flattened, and with a ½-in. hole to receive the pin of a bracket, is fixed under the seat. The forward end is t up as shown in Fig. 67, and fixed to the pad, wh a hollow cube of wood covered with cloth. The ment of the rider's knees from side to side ac the rod N, on its central pin, which, in its turn, the arm M, and with it the wheel. When the pad i in a central position by the knees the machine wi straight ahead ; when moved to the right or le machine will turn in the same direction. The which measures 18 in. by 12 in., is a plain board ported by two springs, and has a back rest cushion. It is adjustable vertically by the tw screws in the frame at the lugs S, S.

CHAPTER VII.

BRAZING.

ꞩ term "brazing" implies hard soldering, or brass lering. Ordinary brass filings are not suitable for purpose, brazing metal being a specially prepared ; brass, the proportions of which may be: 2 parts per; 1 part zinc. In addition to the brazing metal, or elter," as it is called, some borax is required to act flux. When applied moist to a heated joint, borax l penetrate to every part of a narrow crack. It can be ght in a powdered state, but it is preferable to buy it he lump and pound it for oneself. Brazing may be e with a fire only, with a blow-pipe only, or with h in combination. The disadvantage of brazing with e only is that the under side of the part which is being zed gets more heat than the upper side, whereas the t ought to be equal all round. The danger, therefore, uard against is the burning of the tubes on the under before the upper side is sufficiently heated to make brazing metal, or solder, run. If a steel tube, which t best but $\frac{1}{16}$ in. thick, gets partially burnt, or even tered, it is practically ruined for cycle work, and had ter be thrown aside as useless. To braze without a requires a good strong blow-pipe, with a gas supply ough a pipe of not less than $\frac{3}{8}$-in. bore. The blow- e is fed with gas and air in combination, the air ving to intensify the gas flame; the air blast is duced by a bellows, and the blast must be sufficiently ng to produce the most heat from the gas combined h it.

To braze with a blow-pipe only, a carbon block or a p of good charcoal is placed beneath the joint to be zed. The blow-pipe, if efficient, will heat up both metal and the charcoal block to a proper degree in a few minutes, thus practically heating the metal a round. This is the cleanest and safest method o brazing, as the upper side is, if anything, heated in higher degree than the under, and if the work is remove as soon as the spelter runs there is little danger o burning. The heat, too, has been concentrated on on spot, and a much shorter length of the tube has bee heated than would have been the case with the ope fire. To braze with the fire and the pipe in combinatio is the speediest way of all, but great care must be take that the fire does not heat the under side to burnin before the blow-pipe, operating on the upper side, ha made the solder run there. Brazing by this combine method requires, of course, a fan for the forge, and separate bellows for the blow-pipe.

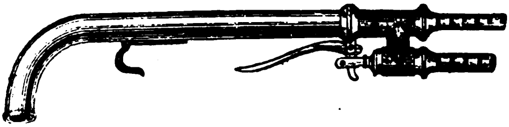


Fig. 74.—Patent Blow-pipe.

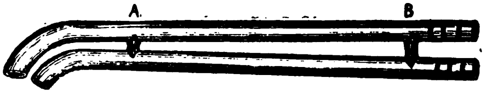


Fig. 75.—Home-made Blow-pipe.

With care, excellent work may be accomplished b the use of a charcoal fire only, the air blast bein produced from a small fan worked by a hand or foo lever. Charcoal is preferable as a fuel, as it gives grea heat, and makes little or no smoke.

A serviceable set of brazing apparatus will cost fro £4 to £5. A blow-pipe only, Fig. 74, may be bought fo from 25s. to 30s. In addition to this a bellows or fa will be required, from which to obtain the blast, as we as rubber piping for both gas and air, and a pan to hol ke or breeze. A cheap makeshift may be rigged shown by Figs. 75 and 76. Fig. 75 represents w-pipe made of two pieces of ½-in. gaspipe, l together at A and B by brazing or screwing two

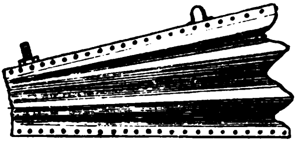


Fig. 76.—Elevation of Home-made Bellows.

s of smaller gaspipe or iron rod to them, and ing the ends in such a manner that the air blast will directly over the opening where the gas issues. 76 represents a home-made bellows, constructed

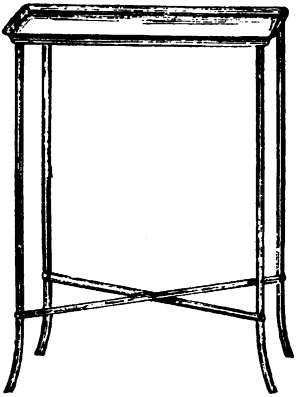


Fig. 77.—Home-made Brazing Hearth.

the lid and bottom of a round cheese-box with some er, or other air-tight flexible material, nailed tightly d the edges. This bellows may be made of any e. A short piece of gaspipe can be screwed in the nd fixed by one nut inside and another nut outside. his pipe is attached the rubber tube which conveys air to the blow-pipe. An air hole, covered by a st leather flap hinged inside is made in the top, and foot strap is nailed or screwed on to work a movab part up and down by pedal action. Fig. 77 represen a stand or hearth, with the frame made of ⅜-in. roun iron, and the top—an old tea-tray—riveted to it.

Bellows alone, if small, would be of no use for cyc brazing, but they could be used to supply a blow-pi large enough for the work. The pipe itself woul require to have at least a ⅝-in. gas supply pipe an a blast strong enough to blow it. The bellows illu trated by Fig. 78 will be found sufficient in pow

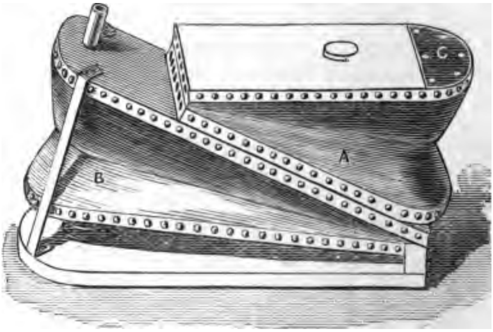


Fig. 78.—Elevation of Foot Blower.

for ordinary purposes. A is the feed bellows, and B th reservoir to which the outlet pipe is attached. Th reservoir is filled by pressing the foot on C, the out rounded end of A, which is shod with an iron plate t protect it. Fig. 79 represents the sole, or ground boar 14 in. long by 10 in. broad, with one end semicircular across the straight end is a fillet D, 1½ in. square. Th top of the reservoir (Fig. 80) is 14 in. by 10 in.; i straight end is screwed to the fillet D on the sole, an sloping upwards, has a space of 8 in. between it and t sole at the circular end. It is guarded at this hei by two iron stays, one of which is shown by Fig.

The stays are 9 in. long by 1¼ in. by ¼ in., one end of each stay is screwed to the upper side of the sole, the other to the upper side of the reservoir, as shown by Fig. 78. The bottom of the reservoir measures 12½ in. by 10 in., and is hinged close behind the fillet D on the sole. The leather forming the sides should be ample enough to allow the reservoir to rise at least 7 in. A spring similar to a sofa spring is inserted between the

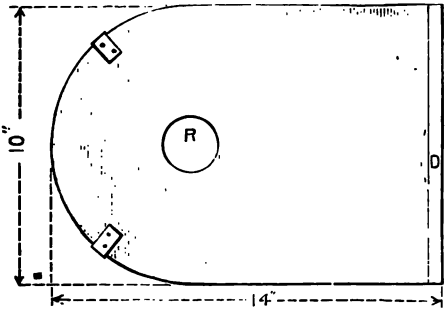


Fig. 79.—Sole Board for Foot Blower.

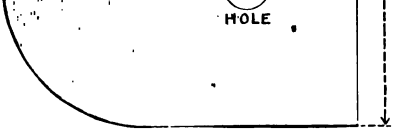


Fig. 80.—Upper Board of Reservoir.

k and the hinged board; it should be strong enough d so placed as to push up the board quite against the pper board of the reservoir. In this upper board, Fig. 80, a 2-in. hole is cut for a valve. It consi a piece of leather, inside the reservoir, nailed b edge to the board, with a piece of wood nailed o back of the leather to stiffen it. It needs no s as the pressure of the wind inside keeps it shut necessary.

The feed bellows is placed on top of the rese with its semicircular end projecting over the s

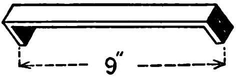


Fig. 81.—Iron Back-stay for Foot Blower.

end of the reservoir. It consists of two boards mea 12 in. by 10 in. and ¾ in. thick (Fig. 82). At straight ends these are hinged together with str leather only. The leather covering of the feed b should be large enough to allow a 6 in. rise and the upper board. In the lower board a hole corresponding with the hole in the reservoir, a

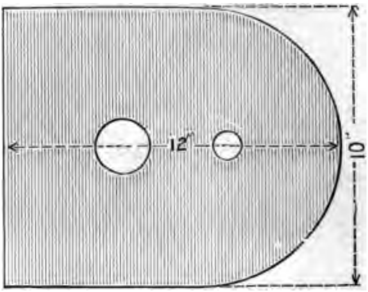


Fig. 82.—Upper Board of Feed-bellows.

the upper board a 1¼ in. valve hole is cut and a is fitted inside it similar to that inside the rese Inside the feed bellows is a spiral spring of suf strength to push the upper board up to its full e

The position of this spring is shown by the smaller circle in Fig. 82.

The sole board (Fig. 79), with its fillet D (see Fig. 83), may be made of pinewood; the others, for the reservoir and feed bellows, should be of hardwood, such as ash or elm. The leather is put on with its smooth side outwards. It is fixed to the edges of the boards with broad-headed galvanised tacks, which are specially made for this work. Strips of leather $\frac{3}{8}$ in. broad are placed along the edges over the leather covering and under the tacks, and these are put in before the top board is nailed to the leather covering, so close together that the row of heads almost touch. The feed bellows is screwed firmly down on the reservoir and made air-tight all round. The iron tread plate on top of the feed bellows is semicircular, $\frac{1}{16}$ in. thick, and is fixed on with screws. On the top of the feed bellows and covering the valve hole a hollow cap, with one side open, should be fitted; its purpose is to prevent dust or other substances from getting through the valve hole. Fig. 83 is a section of the complete bellows, with the various parts lettered: A, feed bellows; B, reservoir; C, tread plate; D, fillet; E, feed spring; F, reservoir spring: G, sole board; H, lower board of reservoir; I, upper board of reservoir; J, lower board of feed bellows; K, upper board of feed bellows; L, iron back-stay; M, cap to protect valve; N, feed valve; , reservoir valve. A short brass tube for attaching ubber tube is shown projecting upwards from B.

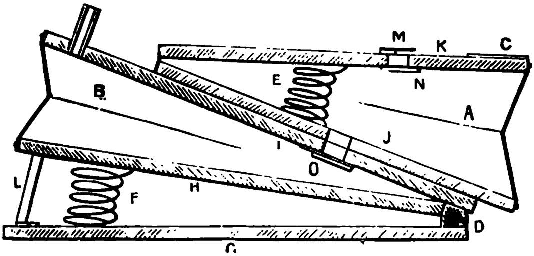


Fig. 83.—Longitudinal Section of Foot Blower.

The easiest joints to braze in a cycle frame are tho
where tubes join at an acute angle. Assuming th
they are properly fitted, and pinned ready for brazin
fill all the screw holes with moistened clay; pipe-cl
will do, or ordinary clay, mixed well to a good stiffnes
but it must be free from sand or gravel. Tie a piece
No. 16 soft brass wire round both tubes just over t
joints, mix a little powdered borax in a dish with wat
to the consistency of thick cream, drop a little of th
into each tube, along with as much granulated spelt
as a threepenny-bit would lift, and let it settle o
the solid tenons inside the tubes. Having made a sma
clear fire of charcoal, place the work over it, heat up th
parts a little, and put some of the moistened borax jus
over the brass wire at the joints. The steel should b
made hot enough to cause the borax to fizzle, and aft
a while it will melt and run over the parts to be brazed
Now provide a piece of pine wood to burn over th
joint; this is the substitute for a blow-pipe; its purpo
is to help the heating of the upper side of the wor
which it does surprisingly well if properly manage
Place the work over the centre of the fire (but witho
allowing the brass on the joint to touch the cinders), an
blow, not too strongly; sprinkle a little dry borax ove
the wire, and take care to hold the work so that th
solder inside the tube does not run out. While blo
ing, place the piece of pine wood over the joint, whe
it will burn fiercely, and throw its flame downward
on the work. When the under side of the wor
reaches a clear red, but not white, heat, turn it ove
and apply more borax to the upturned side, keepin
the wood still burning.

In a few minutes the brass wire being melte
will run and disappear, and a yellowing of the flam
will indicate that the spelter inside has also melte
The instant the brass wire disappears lift the wor
from the fire, and hold the tube so that the spelt
inside will settle in the joint. Throw a little commo
salt over the heated part, then with a piece of iro

: all scale so as to leave the work much easier afterwards.

ol the work, it should stand till the red heat rs; then it should be dipped in and out of 'eral times, or water allowed to trickle on to it y cold. If it were left to cool without water, tube getting cold long before the solid part at would become hard and brittle; so the use is to cool down the solid parts as quickly as . The two joints on this part of the frame th be brazed at once, for, being so near each ere is no difficulty in heating up both at once; necessary to keep both at the same temperature, ne brass wires on both will melt simultaneously. ier simple brazing joint is the T-piece to the ar. The extension tube must be pinned to the and the T-piece to the handle bar; brass wires tied round as before, and spelter and borax n the same way. Care should be taken to tilt on the fire so that the wire on the handle bar into the joint. This part will heat up and braze kly, there being hardly any solid metal about it. her more difficult brazing is the triple joint ont fork crown. The two fork-ends should l into the lower ends before the upper ends are o the crown piece. The fork-ends, after being , should be filed up and bored for the axle, after e upper ends of the fork and the lower ends of ng tube may be pinned to the crown-piece. The nts may be heated and brazed all at once, wi s lying edges upwards on the fire, and the tube somewhat elevated, so that the solder ay lie at the lower end, where it is wanted. forks, being now closed at their lower ends, ach have a small ventilating hole bored to am to escape, and before pinning them to the ach fork should have some moist borax and placed inside it. Tie wires round all three before, and use a piece of wood at least 3 in.

broad to burn over. To prevent burning, which w be sure to happen before the upper side was hot enc to melt the wires, turn the work upside down, as bei The object of turning over is to get the cold side he up, whilst the upturned hot side is kept hot by the p of wood burning over it. With a blow-pipe all t joints would be done separately, one after the ot and no wood need be used. Anyone attempting brazing of work such as this should provide hin with a good blow-pipe and foot blower. There then be no risk of burning, the work will be m cleaner, and much more easily filed up afterwards.

The method of brazing a tube into an outside that is, one that has a tube brazed inside it, will nov described; an inside lug is one which is fitted into a t Outside lugs are, perhaps, more popular than in lugs, though the latter may be used with advantag some cases. First drill or bore the lug out to the pr size, angle, and depth, and make sure that the tube the hole tightly. This is one of the chief advant of an outside lug, for it is always easy to bore a l to a fixed size, irrespective of the gauge of the tu whereas with an inside lug the gauge of the tube to be considered. This will be easily seen if a t of, say, 22 B.W.G. is compared with one of 10 B.W both of the same external diameter. If it can be d without, no oil or soap lees should be used in drilli or the chances are that a perfect brazed joint will be obtained; it is always difficult to get rid of traces of grease, and even a trace of oil or soap is eno to spoil a brazing job.

Having cleaned the end of the tube with emery cl insert it at once into the lug and drive it home wit mallet. Then put a pin through for extra security, a if possible, proceed to braze it immediately. G care must be taken to have the surfaces chemic clean—that is, not only free from dirt, but free fr grease and tarnish; therefore, do not touch t brightened surfaces of the lug and the tube.

To still further increase the chances of obtaining successful joint, two or three shallow grooves may filed in a spiral direction on the work before fixing together (see Fig. 86). It will be quite clear that brass will have a better chance to get between the

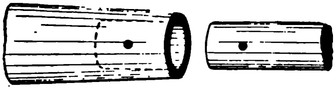
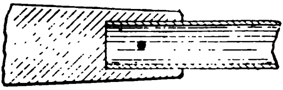


Fig. 84.—Outside Lug ready for being Brazed.

faces when the grooves are filed than would be the e if they were absent. Do not cut them deep; a re scratch with a round file will do. The object making these grooves is to provide a channel for



g. 85.—Section through Outside Lug after being Brazed.

solder to run in. Joints that fit quite tight are n difficult to braze.

The same directions apply in the case of an inside except that the grooves are cut in the outside

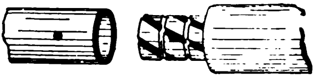


Fig. 86.—Inside Lug ready for being Brazed.

face of the lug itself, and one or two grooves are ed in its surface when fitting to the tube, the pose of these being also to aid the making of an ctive joint. If it is desired to lighten the lug, l it through in the same direction as that of tube (Fig. 87), but it is then necessary to plug the end of the hole with a circular piece of sheet iron. The method of doing this is shown in Fig and its purpose is to prevent the spelter from run into the hole instead of into the joint. Place about e quantities of borax and spelter in the tube, in whi small air hole should have been previously dril insert the lug, and pin up. In this case modera coarse spelter cuttings, and a sufficient quantit fill the joint, are used.

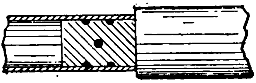


Fig. 87.—Section through Inside Lug after being Bra

In Fig. 84, A represents the outside lug, the do lines indicating the size of the hole for the tub Fig. 85 is an enlarged longitudinal section of the fini joint, E indicating the pin in the pin hole. In Fig A denotes the tube; B the solid or inside lug, sho the grooves and file slots for the brazing metal to into; Fig. 87 represents the joint in section; the tion of the pin and pin holes being indicated by black dots.

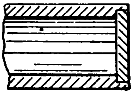


Fig. 88.—Method of Plugging End of Tube.

The method of plugging the end of the lug is illust by Fig. 88.

Before brazing the fork blades of a front-driver t head, drill an air-hole inside each fork about 3 i 4 in. from the bearing (all air-holes should b small as possible). Load with brass and borax, k the blades on to the head, drill and fit two peg screws to secure the fork-blades to the head, and b up, with the hub and bearings all in position.

ill keep the bearings at the exact distance apart. raze one joint at a time, with the forks held at a ant of about 45°, or else perpendicular, head downards, if the hearth is deep enough to allow the head be buried in the breeze. If the joints are well aded with brass, do not put any on the outside—t least, not till the melted brass has been drawn rough from the inside with borax only. This will nsure a sound joint if the brass is not allowed to un away from the joint into the fire.

A necessary precaution in brazing is to protect all nished parts as much as possible from the fire, all screw oles or sockets should be filled with clay. The steering arrel, the L-pin socket, and the two lugs that receive e rear tubes should be filled, at least at the ends. In epairing work, the enamel, if any, must be cleaned off round any parts where a joint is to be made.

When all the joints have been satisfactorily brazed e filing up must be taken in hand, and those parts at have been in the fire will give most labour in filing. he rough scale should be removed with an old worn le, then better ones may be employed. All parts that ave been coated with borax must be filed up clean, as borax left on would soon show itself on the finished machine even through the enamelling. If the tubes ave a good clean surface they need not be filed in their ength ; a good rubbing with emery and oil will be fficient, but for a job to look nice, when enamelled, ll parts that have been filed should be afterwards ade as smooth as the body of a new tube, for enamel not intended to cover up rough work. Caustic soda the safest thing to use as a pickle to remove borax om the brazed parts of a frame. An iron tank heated gas, or with steam pipes running through it, will required to boil the solution in. Get the water to iling point, dissolve the caustic soda, and keep it just der boiling point whilst in use. Acids are detrimental the steel of the tubes. The sand-blast process is, wever, most effective, although some operators use only files and emery to finish the surface, preparatory to enamelling. For the parts which are to be polished for plating, various grades of emery wheels are employed. These are wooden discs covered with leather, coated with emery: three or four of these wheels will be sufficient. When a very fine finish is wanted, a wheel fed with pumice stone or Tripoli powder will be necessary. Emery wheels are fixed on their own spindles, and are driven by a flywheel, kept going by two treadles mounted in a frame similar to a knife-grinder's.

When the bottom brackets in a rear-driven machine are brazed to the tubes, the end cups are left out, as these would be softened in the process. They are afterwards sweated in with soft, or tinmen's solder. If the bracket is without cups, and simply has the ends hollowed out to form a ball-race, they, of course, get softened by heat in brazing, and must be re-hardened and tempered afterwards; but the hollow for the balls is very likely to get out of truth in the process, and the same applies to the ball-bearing at the head. To braze the neck into the backbone, charge the inside with a mixture, of about equal parts by bulk of spelter and borax, and when it melts, by means of an iron rod and borax, draw it through to the outside. When brazing a lug to a tube of light gauge, scaling and burning can be prevented by frequent applications of borax, and by heating the lug or heavier part first as much as possible.

CHAPTER VIII

HOW TO MAKE AND FIT GEAR CASES.

ITH any mechanical contrivance where friction es place there is no method of lubrication so perfect its action as constant or bath lubrication, provided oil and parts lubricated can be kept perfectly free m dust and dirt. Oil applied too freely to a bearing

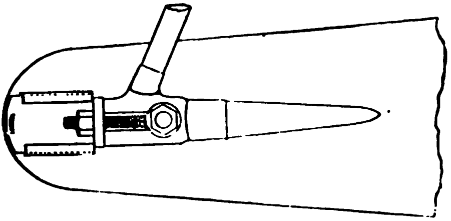


Fig. 89.—End of Case Fitted with Slide.

ich is exposed to dust, dirt, and grit, is likely t ve less beneficial than a small quantity applied oft the overflow of oil will attract dust. and this w k into the bearing, and cause an increase of what t is intended to lessen—namely, friction. Given a perly-fitting bearing with sufficient surface, and pro- ed that the load carried is light enough, there will be metallic contact at all, the thin film of oil keeping the faces apart and insuring a minimum of friction. This irable perfection of lubrication and absence of metal- contact cannot be obtained in the wheel bearings of odern cycle, as the bearing surfaces are too small for load carried. But with the chain a difference exists, much as the force applied is distributed over a large nber of journals and pins, the combined areas of ich form a very considerable bearing surface. Thus, with a standard pattern safety having chain whee say, eight and seventeen teeth, there would be from teen to seventeen points of contact, and with one ha seven and sixteen teeth, from thirteen to four according to the distance the chain-wheels are pl apar

Gear cases are often made of tinned plate, sold to the frame of the machine in such a manner make an oil-tight case that completely encloses chain and chain-wheels. The chain constantly into the oil in the bottom of the case, carries it r

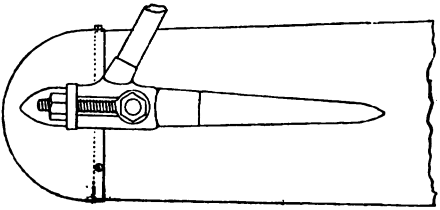


Fig. 90.—Case with End-piece Joined on.

ad distributes it all over the teeth of both c wheels into the rivet holes and side-plates of the c where there is always a lot of friction in an imperf lubricated chain. As a means of diminishing fric nd consequently providing easier running, its effici not be questioned. The difference in riding e achines, with and without the case, is most ma specially up hill and against the wind, or on h roads. In fact, a machine is not complete as a road without it. It has not been generally adopted for t racing, as its advantages are not there so marked. instance, in a short distance race, the chain ca thoroughly cleaned and lubricated before starting, the race is over before it has time to get very di but for long distance path racing a gear case is tinctly an advantage. Its weight—1½ lb. to 2½ lbs small when compared with the weight of the mac and the rider.

A machine to be fitted with a gear case such as that which forms the subject of this chapter, and which is constructed on the lines of the original Carter case, must have ⅜ in. clearance between the spokes and chain-wheel on the hub, otherwise there will not be sufficient room for the thickness of the case, the disc, and clearance between each.

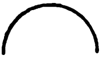


Fig. 91.—Section of Moulding for Gear Case.

Get the frame ready to be fitted by cleaning and tinning the parts the case is to be soldered to. These will be the right-hand fork end, with the bottom and top back-stays for about 3 in., the bottom back-stay for about 6 in. to 8 in. from the bracket, where the back of the case crosses it, and also round the bottom bracket for about 1 in. from the right-hand side. Put in the bottom axle and chain-wheel (without the cranks) and

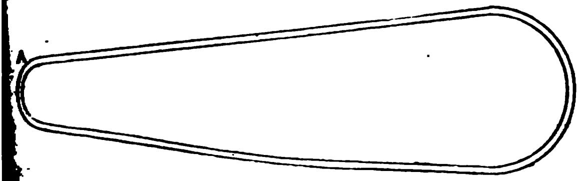
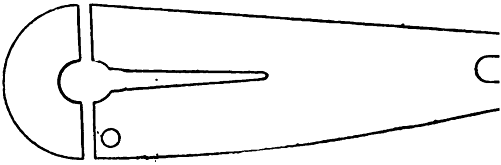


Fig. 92.—Elevation of Moulding for Gear Case.

place in the fork ends a hub of exactly the same di ions as the one to be ultimately used. Adjust the chain rather tightly, with the chain adjusting screw in position.

In making the case, the first job will be the edge moulding, which for one style of end may be rolled in one piece, or, for another style, in two straight pieces for top and bottom, and two semicircular pieces for the ends. Figs. 89 and 90 show the two different methods of making the ends. Fig. 89 is the style usually adopted.

The advantages claimed for it are that the oil i liable to escape, and that it is neater in appearanc lighter. With the arrangement shown by Fi the chain is taken on and off and the wheel re more readily. When fitting the case with method, one is better able to see that the chai truly in the centre; moreover it is easier to cle the case, when necessary, with this than with the method. To fit a case with an end such as Fig. 16 the moulding rolled to section as Fig. 91—1 in. wi chains up to $\frac{5}{16}$ in., and $1\frac{1}{8}$ in. wide for chains $\frac{3}{8}$ i over. The sizes named are for block chains, like Fi



Figs. 93 and 94.—Pieces for Back of Gear Cas

and 125. Some roller chains will require mo $1\frac{1}{4}$ in. wide. Form the moulding as Fig. 29, allowi end curves to be $\frac{1}{2}$ in. greater in radius than the ex radius of the chain-wheels, measuring over the the teeth. The extreme length of the moulding, ov will be regulated by the length of the wheel bas the size of the fork ends. It should be long e to allow the back wheel to be withdrawn sid from the case when pulled out clear of the fork Fit, and in two or three places fix, the mould the frame, first soldering a small piece of tin s as Fig. 99 at the point marked A in Fig. 92 to the oil thrown off from the rapidly revolving chain-wheel. Take care to have the chain and wheel centres central with the radius of the Cut out the back pieces as Figs. 93 and 94 to o the edges of the moulding $\frac{1}{8}$ in., and to fit round the stay and bottom bracket.

m "taggar" tin cut pieces as shown by Figs. 93 about ⅜ in. from edges, and from a piece of cut out pieces similar in shape to the "taggar" , but ¼ in. less all round. Place the back piece the iron plate and solder up thoroughly the r" lining to it with the flannel between. This the side and deadens sound. It may be urther stiffened by punching holes in the r" and corresponding ones in the flannel (before ıg up), and soldering the side and lining r through the holes, which should be about diameter.

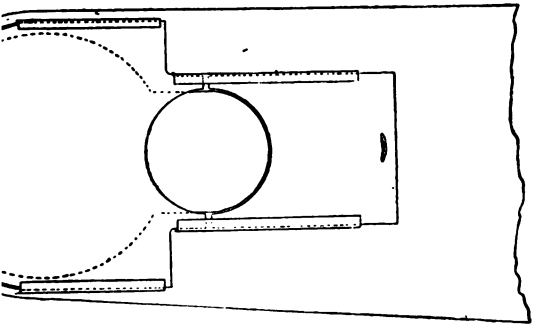


Fig. 95.—Method of Arranging Back Slide.

:he guide and slide to cover the slot for adjust- nd the hole through which the hub chain-wheel drawn. The arrangement of the back slide is at Fig. 95. This part requires careful fitting re the exclusion of dust and dirt, to be free of b, and to have the correct amount of slot to r the proper adjustment of the chain.

h this part satisfactorily fitted, solder on the ɔ the moulding and frame. Whilst this is lone it will be as well to solder a temporary m the fork end to the bottom of the moulding, or ılding may be pushed out of position in doing so, stay can be removed after the back is on.

A rigid foundation to work to is the vided. Solder the moulding to the frame, an off all superfluous solder from the joints putting on the front. The oil hole and screw should, of course, be made and fitted before solde the back. The whole case should be arranged so lower edge is level with the bottom edge of th in the chain. This will allow the chain to jus the surface of the oil bath, which is all that is re

Next fit and fix the rim of the lever lid to the the case. Select a lid which will admit of the wheel passing freely through its rim, or, if t any possibility of the gear being changed for a one at any future time, select one that will a chain-wheel with one more tooth than the o

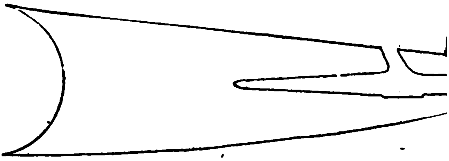
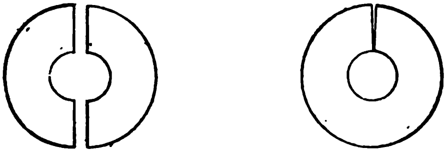


Fig. 96.—Slide for Front of Gear Case.

fitted. These lever lids are the same as thos used for paint tins, and form a ready method of at the bottom bracket for repairs or cleaning. hole in the centre of the lid to admit the axle en

In fitting the front and the stay, cut out th as Fig. 96, and fit and line it as described for th Make and fit a stay of tin-plate to prevent t sides from collapsing under pressure. Sol stay to the inside of the back, and pad a the front where it comes in contact with i it may be soldered to the front and not In fitting this stay, be careful to get it qui with the two edges of the moulding. A s edge placed across the two edges should jus the stay. If it is higher than the edges the be a "belly" or bulge on the side when soldered up; if lower than the edges of the moulding, the side will be concave when finished. Solder the side on, and make and fit the small piece, B, making due allowance for the chain adjustment and withdrawal of the wheel. Before finally soldering on the front, carefully examine to see that the chain is quite central and does not touch anywhere when fairly slack.



Figs. 97 and 98.—Discs for Soldering to Axle.

A flange of tin-plate of good strength, about 4 in. in diameter, must be soldered to the bottom axle, to prevent oil running out of the hole in the lever lid. Another flange equal in diameter to the hub chain-wheel must be soldered on the hub so as to clear the chain and the inside of the back. This latter flange

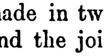


Fig. 99.—Shape of Tin Soldered in Gear Case.

must be very carefully fixed, or it will be liable t catch the chain or rub against the side of the case. The flanges may be made in two pieces, as Fig. 97, or one piece, as Fig. 98, and the joints should be soldered up after they are in position. A third flange will be required, soldered to the back wheel axle between the outside of the hub chain-wheel and the inside of the front.

The appearance of the case when enamelled may be greatly improved if the joints of the moulding and sides have been filled up with solder, and afterwards filed off flush and rubbed smooth with emery cloth. A small

tin-plate will be required to cover the fork end
it is kept in place by being slipped on over the spir
before the nut is screwed on. When finished, thoroug
wash the case out with paraffin oil to remove all
and filings. The mouldings and sides should be m
from plates known in the tin trade as "common,"
the discs from XX. Any tin-plate worker having a
of bath moulding rolls will roll the mouldings at a s
charge.

CHAPTER IX.

FITTINGS AND ACCESSORIES.

chapter is devoted to various appurtenances sary for the equipment of cycles. Many of the dealt with may be purchased ready made, but

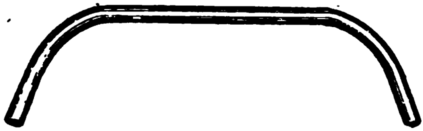


Fig. 100.—Square Bend Handle-bar.

are no barriers to prevent their construction by rs who possess the requisite tools, time, and skill.

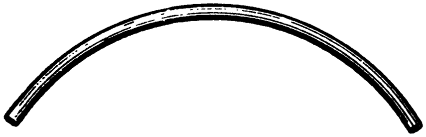


Fig. 101 —Plain Sweep Handle-bar.

n making a handle-bar, the shape is the first ation. Make the bar about 26 in. over all, with

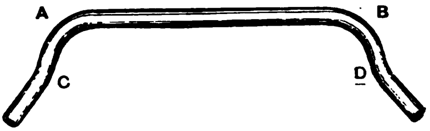


Fig. 102.—Humber Drop Handle-bar.

lles on; this will be wide enough to give the rider pportunity to properly control the machine; nothing be gained by having a longer handle-bar. Figs. 100 and 102 represent three forms of handle-bars in general use. Figs. 100 and 101 will be the easiest to ben and require about 3 in. less tube for the **T**; but Fig. 10 is perhaps the most popular, looks well, and is comfortable if not set too low. It is known as the "Humbe dropped" pattern, and is best suited to the machin

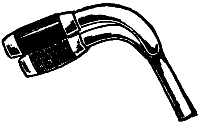


Fig. 103.—Upturned Handle-bar.

described in Chapter III. To make it, take 34 in. o weldless tube ⅞-in. diam. 18 B.W.G.; fill it with fine sand

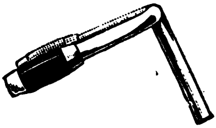


Fig. 104.—Flat Handle-bar.

rammed tight before plugging the ends with tow o corks If the sand is loosely put in the tube, it will kin

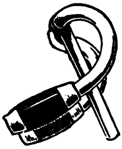


Fig. 105.—Racing Handle-bar.

in the sharpest part of the bend. Heat the tube t it is a bright red, and bend the two curves A and B (F 102), taking care to get them exactly alike before p ceeding with the other two bends marked C and D. several handle-bars are wanted alike, it will pay to be em on a jig, which may be made of ⅞-in. rim steel, ent to the shape desired for the handle-bar. For ending only one, it will be better to use a ⅛-in. vice-block hold the bar whilst it is pulled to shape. Care must e taken to avoid making dents and flats in the tube by king several heats for each curve, and bending only hilst the tube is soft. When bent to satisfaction,

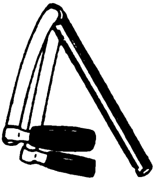


Fig. 106.—Handle-bar for Front Driver.

easure from the two ends to find the centre of the bar, nd proceed to make the lap-joint of the T. About 10½ in. of tube ⅞-in. diam. 18 B.W.G. is wanted for this. he trouble of making the lap-joint may be avoided by sing an unsplit T lug, drilled with ⅞ in. hole to take the

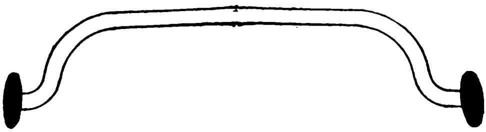


Fig. 107.—Square Drop Handle-bar.

r, and turned to fit in the ⅞-in. T tube. The T must slipped on the centre of the bar before the ends are nt, but the lap-joint, described on page 63, makes a ater job, and is lighter than the other.

Handle-bars may be purchased ready made, and three igns of the Abingdon make are represented by the companying illustrations. Fig. 103 is known as the turned bar, Fig. 104 is the flat bar, and Fig. 105 is the ing bar.

The handle-bar for a front driver, such as desc in Chap. II., is very different from that on a rear d The seat being closer up to the head on the fc necessitates the handles being carried forward to o a comfortable position, instead of taking a back curve, as on a rear driver. A good form of handl

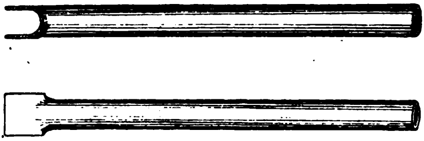


Fig. 108.—T Lap-joint for Handle-bar.

for a front driver is illustrated by Fig. 106. Th should be bent to shape, from ⅞ in. by 18 B.W.G., an short pieces for the handles are made from ¾ in. B.W.G., lap-jointed on to the main bar.

An alternative method of making the handle-

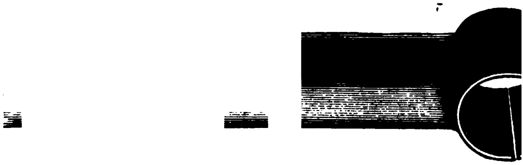


Fig. 109.—Handle-bar T-lug.

shown at Fig. 107. It is bent all in one piece, h shaped handles fixed to the ends, and may be made a lap-joint (Fig. 108) to go round the handle-bar or a T-lug, as Fig. 109. The lap-joint is lighter and n than the T-lug, but somewhat more difficult to mak fit, though when well fitted and brazed it is a very factory handle-bar T. Assuming the front fork-tu 1 in. by 16 B.W.G., the usual size, take a piece of ⅞ i 18 B.W.G. tube 6 in. long, mark it down each side cent for about 1½ in., and saw down 1¼ in., taking care the saw does not "go" more one way than the o Open out the sawn part by heating in the fire, andrel about ⅜ in. diameter, and afterwards one e size as the diameter of the handle-bar. In lap-joints, a good "lip" should be made on the .rt of the joint, to obtain a better brazing surface, ι at Fig. 108. This should be worked out with , or small mandrel; it will not be possible to after the joint is opened out to its full size. the tube in the wooden vice-block, to obtain a ı grip whilst hammering; be very quick over the it soon cools, and heating too many times scales cens the tube. The joint should be easily finished heats: a good workman, used to the job, would e two heats to finish it. With the handle-bar l its centre; mark it, and make two other file-ne on each side of the centre one, ¾ in. from it, he centre of the handle-bar is not lost when the ıocked round. Clean the bar for about 1½ in., nside of the lap, removing all scale, etc., ready for Place the bar in the joint, and tap round the they meet on top. Set the bar in its correct drill and tap for two pegging-screws—one on ;, as near the top as possible—and it will then for brazing. It will require some skill to fit ends of the lap so that they meet without the joint loose on the bar. In drilling and any joint to be brazed, do not use oil, as a greasy cannot be brazed. To braze, load from the nd braze with the top of the joint on the fire, the brass through with borax only, and remove ɜ fire as soon as the brass has run well round .

l roadster will require foot-rests, of which there ral varieties. For years the almost universal tting them was to braze to each side of the forks tamping with a projecting piece of ¼-in. round out 3 in. long, upon which was slipped a piece of This was firm, and answered very well, but it ıer heavy. The foot-rest generally used now is -trap pattern, secured to the forks by a screw only. This is satisfactory when the grip goes right round the fork, as shown by Fig. 110, and does not simply grip each edge, as, with the vibration only, the rests will slide down the fork. Fix the foot-rests in a position that may be reached comfortably with the feet when sitting upright in the saddle.

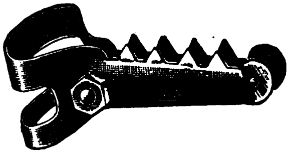


Fig. 110.—Adjustable Foot-Rest.

The step to be used must also be decided upon. A simple and light form consists of an extension of the back wheel-spindle through the left-hand nut for about 2 in., as shown at Fig. 50, p. 59. The projecting part is notched to prevent the rider's foot from slipping. A difficulty may arise about obtaining a ready-made spindle sufficiently long, but the spindle of home-made hubs may be left as long as required. A steel stamping may

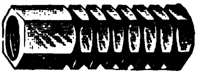


Fig. 111.—Step for screwing to Hub Axle.

be bought for brazing to the bottom back-stay nea the fork end, or a step of drop pattern may be had t slip over the spindle between the nut and fork en before putting on the nut to secure it. Do not use malleable casting for a step, as it is unsuitable for th part; a very nasty accident may occur should the ste suddenly snap whilst mounting. A step to screw to th hub axle is illustrated in Fig. 111.

Brakes are secured to the handle-bar by a detachabl lug, as Fig. 112; the lever should be arranged to wor freely, yet without shake or play, and sufficient movement should be allowed for in order that the brake may be properly applied. If the forks have been cut off to allow the proper clearance, the extreme end of the lever handle should move through an arc about 3 in. long. There are several methods of break adjustment; Figs. 113 and 114 show two, either of which may be adopted with equal success. Fig. 113 will require about 1 ft. of ⅜-in. Bessemer steel rod, and a malleable casting, as shown, for the adjustment. This will be more simple and cheaper to make than Fig. 114, which is lighter and neater. It will require about 1 ft. of ⅜-in. diam. 18 B.W.G. tube, a ¼-in. plunger-rod turned to nicely fit the tube, and a small split-lug brazed or fitted loosely to the ⅜-in. tube for gripping the plunger-rod. Braze the brake rod or tube to the brake-spoon, and set it square. See that the rod works freely but without shake, in the hole in the brake-lug, also that it is parallel with the head-tube. To bring the brake off the wheel when released, a spring will be required. A simple and effective form is the spiral, fitted on over the brake-

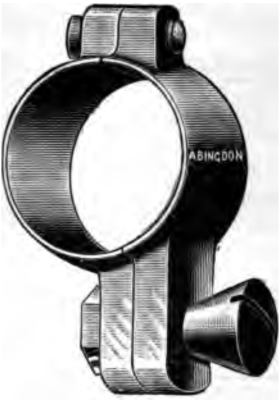


Fig. 112.—Brake Adjustment Lug.

rod or tube between the lug, through which it passes small lug-collar or screw being fixed on the rod or tu at a suitable distance. An efficient brake for a r driver is shown complete by Fig. 115.

A brake for Safeties, which acts automatically soon as the action of back pedalling is commenced the rider, consists of an arm fixed to the fra close to the pedals and between them. On the end this arm, which approaches close to the tyre of t driving wheel, there is hinged a spoon brake. The pi

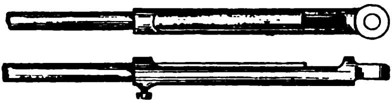


Fig. 113.—Brake Adjustment Castings.

on which the spoon is secured projects on the chain si and upon it a crank is fixed. A roller projects at rig angles to the crank, and this roller is ordinarily betwe the upper and lower parts of the chain, though n

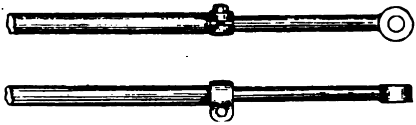


Fig. 114.—Brake Adjustment Tube.

touching either. When the lower chain takes on stretch, as it does as soon as back pedalling is co menced, the roller is caught by it and raised with This turns the crank and applies the spoon to the tyr

A simple brake to work by the feet on the fr wheel and behind the fork crown may be made forming a large brake spoon with well-rounded edg and hinging it to the under part of the fork-crown. projection on each side of the spoon should be form to enable the pressure to be applied by both feet. short spiral spring should be fitted, to keep the spo ie **wheel** when not in use. As this form of brake id the crown is very powerful, care must be taken o apply it too suddenly. Another form of foot is shown, fitted to a machine, by Fig. 116.

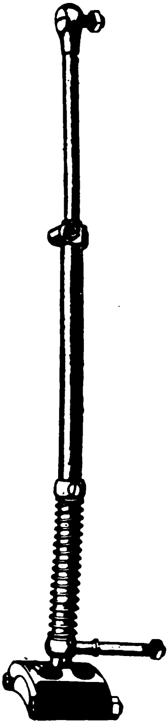


Fig. 115.—Brake for Rear Driver

he lamp-bracket must also receive attention. If a f fittings has been purchased ready machined, this not require much fitting; but if in the rough, it be in one stamping with the handle-bar adjust- ng. In this case drill the lug to fit the front fork-

; drill a $\frac{3}{8}$ in. clearance hole on the left side of the and a $\frac{3}{8}$ in. tapping hole on the right side ; tap for n. Whitworth adjusting screw, and saw through the for clipping to the tube. Slip it in its place and it true, so that when the machine is running the ion to receive the lamp socket is perpendicular square on the flat with the machine.

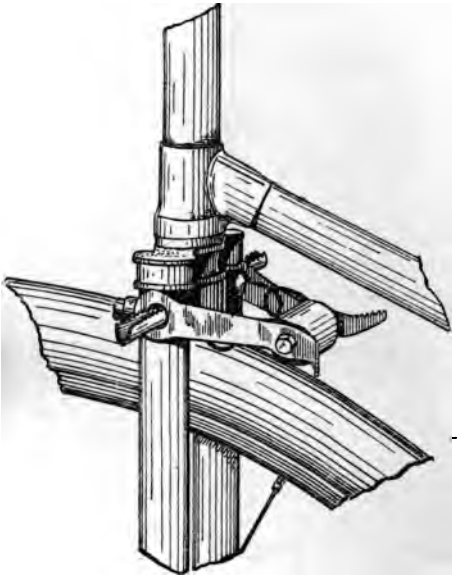


Fig. 116.—Foot Brake Fitted to Machine.

Those who are compelled to ride in all weathers not do better than fit the ordinary sheet steel -guards to their machines ; let them be wide ds, whether the tyres are pneumatic or not. To tail end of the front guard fix a leather flap, ed like an open fan, only not very wide, with the part downwards. This flap, if brought down to ithin 1 in. of the ground, will keep the rider's feet lean. With a gear case also fitted to the machine, and low gear—say, 56 in.—one can ride with comfort nder all circumstances.

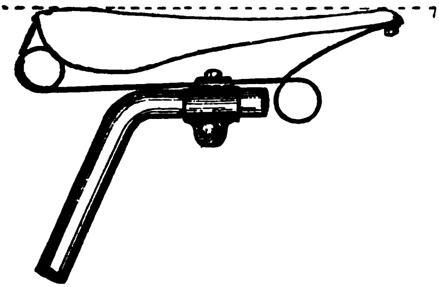


Fig. 117.—Saddle properly Placed.

A flexible mud-guard for Safety machines may be ade of black enamelled leather—that which is enamelled n both sides is best for the purpose. Make paper patterns first, to suit the frame of the machine, then cut

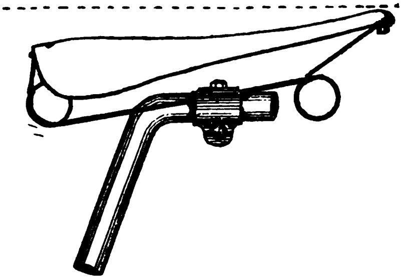


Fig. 118.—Saddle improperly Placed.

the leather guards from the patterns. The front guard should be about 3 in. wide at the crown end and 4 in. to 4½ in. at the bottom, and long enough to come within 2 in. or 3 in. of the ground. It should be fastened in two places by a lace to the crown and to the bottom of t front stay of the machine. The back guard should about 3 in. wide at the bracket end, and from 3½ in. 4 in. wide at the top, and long enough to stand out abo 8 in. or 9 in. from the saddle, beyond which it should supported by stout wire rods. One end should be lac to the bottom bracket, and the other to the brid between the backstays; or if there is no bridge on t machine, then to the stays themselves. These guar are of very little use unless amply wide, and the fro guard must be long and wide at the bottom end, to ke the mud from the rider's feet. However well made a fitted, flexible guards are never so good as rigid ones.

A luggage carrier for a tricycle may be made of mi steel ½ in. by $\frac{3}{16}$ in. thick, bent to suit requiremen and secured to the front steering-tube by broad steel on clips. The framework should be brazed togeth or strongly riveted. Slots should be cut in parts of t framework, where they will weaken it least, for straps pass through with which to secure the luggage.

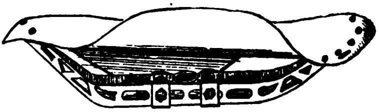


Fig. 119.—Racing Saddle.

Those who have a lamp, or can borrow one similar shape to the one it is wished to make, can easily measu up and cut out patterns of the various parts in brow paper or, if likely to make more than one, in she metal. Place the patterns thus obtained flat on a she of tin plate, and with a scriber mark out on the pla the different pieces required, making due allowan for those having flanges upon their edges. If the lan is required to be strong, use XX tin plates; if want light in weight, use "common." Block the vario patterns into shape, and rivet the parts together. T glasses should be put in after the lamp is japanned, if s to be stoved, as the heat may crack them. If to be ne over with an air-drying japan or enamel, of course does not matter—in fact, it will be better to fix the

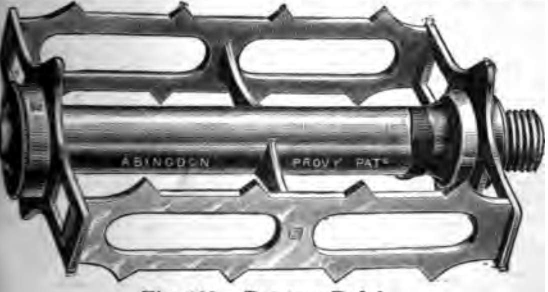


Fig. 120.—Rat-trap Pedal.

lasses first in that case. The plated bell cones in hich the glasses are fixed are not bought ready made,

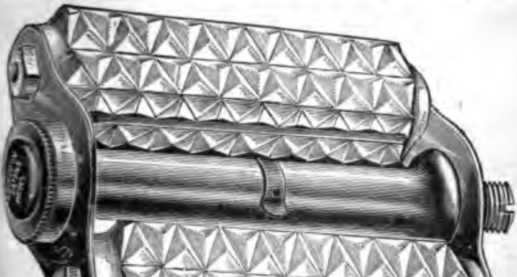


Fig. 121.—Rubber Pedal.

t are made from the sheet, which is copper silver-ated on one side, and may be bought at any sheet-etal dealer's

In choosing a saddle, the rider must be guided by his eight and requirements. For touring and all-round riding, a hammock saddle (Figs. 117 and 118) will be found comfortable. For scorching, Brook's racing saddle (Fig. 119) is a preferable make; but for road riding this saddle will only suit riders up to 10 or 10½ stone, or those who have been used to riding without a spring.

If the L-pin has a ⅝-in. solid top, see that the flat on its under part is so filed that the saddle will lie evenly on the pin, and not tilt on one side when the adjusting screw is tight. With a ⅞-in. hollow L-pin the friction of the saddle-clip is sufficient to grip it firmly when tightened up. The saddle, to be comfortable, should be so placed that a straightedge resting on the nose and rear part will be parallel with the ground when the machine is standing upright. Fig. 117 shows the saddle properly placed. A saddle should be so placed that the rider may sit comfortably in it, and not so that he has to cling to it by holding on to the handles, thus throwing most of his weight on his arms. With a saddle placed as shown at Fig. 118, the weight of the rider's body will be thrown forward upon his arms, and should the handles also be pitched low, the rider will experience great discomfort and fatigue on a long journey.

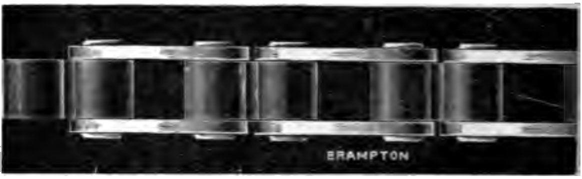


Fig. 122.—The Brampton Chain.

Fig. 123.—Abingdon Double Roller Chain.

Rat-trap (Fig. 120) and rubber (Fig. 121) are the two rieties of pedals in general use; the illustrations show fficiently their construction. The former is mostly ed for racing and road scorching, and should be used ith proper bars or blocks fixed on the soles of the ders' shoes to fit the plates, or else toe-clips to prevent ipping. The rubber pedal is mostly used for steady-going ding, and by those who prefer comfort. Akin to the bber variety may be classed those with felt and cork

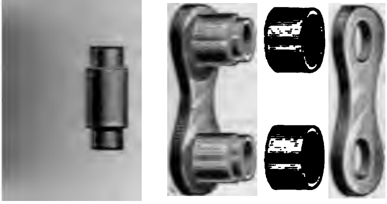


Fig. 124.—Inner Links of Abingdon Double Roller Chain.

i place of the usual rubber blocks. Felt is light, comfortable, and durable; cork is lighter still, but will soon ear out with much riding. In fitting the pedals to e cranks, see that the pedal-nut passes the chain with

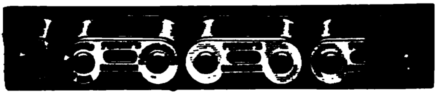


Fig. 125.—Perry's Humber Pattern Chain.

t least ¼ in. of clearance, and that it has suffic learance to miss the bottom back-stay. A miss ll that is required here; a bare ¼ in. is sufficient.

The selection of a suitable driving chain is a matt f importance; a common, soft chain will prove a sour f annoyance and disappointment. When it is con idered that the whole of the power required to drive he machine is transmitted through the chain, it will eadily be understood how important it is to have this eally first-class. There are many varieties of chain in general use.

Fig. 122 represents the Brampton chain; Fig. 123 t Abingdon double roller-chain, the construction of whi will be understood by reference to Fig. 124, whi illustrates the inner pair of links. The Perry Humb pattern chain, Fig. 125, has pen-steel bushes to t rivets. The Simpson lever chain and hub sprocket illustrated by Fig. 126, where A denotes the engagi

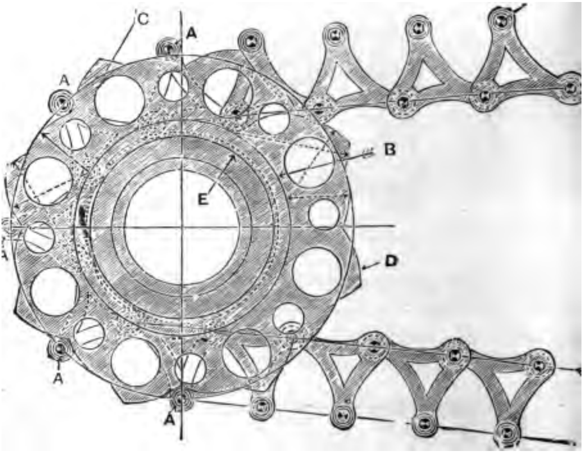


Fig. 126 —The Simpson Lever Chain and Hub Sprocket.

ollers, B the pitch line of the inner hub sprocket, C t ub sprocket pitch line, D the side plates of the h procket, and E the inner hub sprocket.

Chain links are apt to work stiff at times. If t chain is new, the stiffness will wear off with a few mil riding and plenty of oil, but if the stiffness is caused rust, soak the chain for twenty-four hours or so paraffin; afterwards well wipe and then oil it.

CHAPTER X.

WHEEL-MAKING.

The component parts of cycle wheels are hubs, spokes, ims, and tyres. Hubs are referred to as being either "direct" or "tangent." Direct hubs are mostly made from n-metal, with hardened steel bushes, or ball cups, runk or soldered in. Tangent hubs are chiefly made om mild steel, with hardened steel ball cups let in; metimes, however, ball cups and hubs are made in e piece, and both parts hardened.

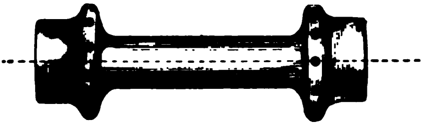


Fig. 127.—Back Hub, showing Position of Spoke Holes.

If a pair of ready-made hubs have been purchased, they will, in all probability, be drilled to receive the spokes. Hubs for tangent spokes are sometimes left not drilled, for, unlike hubs for direct spokes, they do not require any special tools or appliances with which to drill them, although in factories they are drilled in special machines. Draw a spoke line around one of the flanges of the hub, and mark off, by means of a pair of dividers, the required number of spoke-holes; then, with a box square or a straightedge, mark off a point (as shown by Fig. 127) on the opposite flange exactly midway between any two of the holes already marked off on the first flange. In marking off this point, take care to have the straightedge perfectly parallel with the centre of the hub, as the spoke-holes on one flange should be *exactly* midway between those on the other. If a dividing headstock is accessible, the hub may be mounted between centres and marked off by means of a scriber blo without trouble and very quickly.

No one should attempt to drill hubs for direct spok unless possessed of a hub-drilling machine, or son arrangement that will ensure the holes all being drill at exactly the same angle and equidistant from o another.

Before entertaining the question of spokes, choi must be made of a rim suitable to the tyre which it proposed to use; this done, spokes should be made selected with heads adapted to the form of rim decid upon. Hollow rims are preferable to any other form, apart from the weight saved by using them, the ext stiffness in hollow over solid rims is very marke

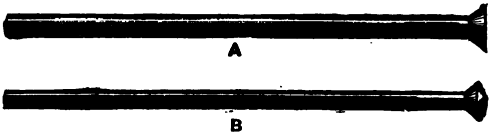


Fig. 128.—Direct Spokes.

Solid rims have, in fact, almost entirely gone out of u There are two forms of spokes in use for cycle wheels namely, direct and tangent. In the direct class are t ordinary straight spokes, of equal gauge from end to en with a head formed as either A or B (Fig. 128). Then t direct butted spoke (Fig. 129) is frequently met with better-class machines. It is a spoke of from 15 to B.W.G., with a butt, or thickened end, of from two three gauges stouter than the main portion. This spo has no head. The hole in the rim is drilled to adn the main or thin portion only, and it must headed in the rim after the exact length has be obtained, and the end screwed. The head may formed in the ordinary bench-vice, but a small headi tool greatly facilitates the operation, and forms a mu better head.

Direct Spokes are most generally used, and prese fewer difficulties than tangent spokes. A direct spoke wheel, besides being easier to make, is easier to clean, and costs less than a tangent wheel, but is somewhat heavier, and not so rigid. A tangent wheel, however, when properly made, will give less trouble to the rider, and, owing to its stiffness, answers better to the tread.

Tangent Spokes, one of which is illustrated by Fig. 130, are wires passed through the hub flange and brought up to the rim at more or less of a tangent. A hub flange to which tangent spokes are fitted is illustrated by Fig. 131. The outer ends of the spokes are not secured to the rims direct, but are held by means of nipples of the form shown by Fig. 132. The square nipples are much to be preferred to hexagonal ones, as they afford a much better hold to the key or spanner, whereas the hexagonal corners soon wear off. Brass nipples are to be preferred to steel nipples, as brass does not rust and bind to the spokes as steel does, making it a matter of great difficulty to tighten a spoke or true a wheel when necessary.

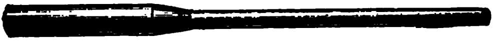


Fig. 129.—Direct Butted Spoke.

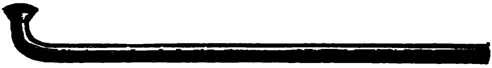


Fig. 130.—Tangent Spoke.

A convenient number of spokes to use will be thirty-six in the back wheel and thirty-two in the front wheel, and a good gauge will be 12 B.W.G. for the back and 13 or 14 B.W.G. for the front wheel. If, however, the hubs are already drilled, the number of spokes must, of course, correspond with the number of holes.

Before commencing to build the rear or driving wheel, it will be necessary to determine on which side of the machine the chain-wheel shall be. Sometimes the make of the hub determines this, as the loose cone should always be on the *left* side of the wheel, for the reason that a loose cone is apt to turn on the spindle with the friction of the balls, especially when dry. When the cone is on the right side, and turns on its spindle, the result is that it winds further *on* the spindle and jams in the hub, stopping the wheel. When placed on the left side, if it turns on its spindle, it winds off towards the fork side, but cannot jam the wheel. Of course, if the wheel is kept properly adjusted and the outside nuts well up, the cone cannot run either way. Some hubs, however, have both cones loose; in this case the nuts must be kept well up, or the right cone will be sure to run in and jam the balls and stop the wheel. This rule with regard to the loose cone must be observed with the front wheel as well as with the back.

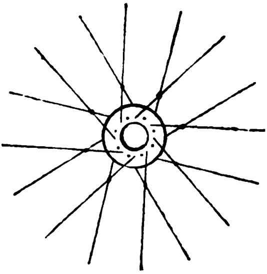


Fig. 131.—Hub Flange Fitted with Tangent Spokes.

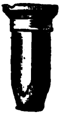


Fig. 132.—Nipple for Tangent Spokes.

Mark off all round the rim for the required number of spoke-holes. Manufacturers who make wheels in large numbers have division rings for the purpose; but as a small maker will probably not possess such an appliance, it will be necessary to set out the rim with the aid of compasses. If, however, a wheel can be obtained having the same number of spokes as are to be put into the pair to be built, time may be saved by tying the rim to the wheel and transferring the position of the spokes. But if such a wheel is not available, ascertain the circumference of the rim by passing a piece of string round the hollow, and divide the circumference by the number of spokes; by this means the divisions for the spokes may be obtained. Start near the brazed joint, and see that it comes between two spoke-holes. Step round the rim in the hollow with a pair of dividers, first making a mark with a centre-punch to start from; then centre-punch all the marks, with the rim hanging on the horn of a high anvil, or across the jaws of a closed leg-vice. Drill the holes alternately about ⅛ in. from each side of a central line drawn round the hollow of the rim; this gives greater support to the rim, and makes a firmer wheel. The holes should be about half a gauge larger than the gauge of the spokes. If the drilling is done with a lathe, let the rim rest on the lathe-bed at the right hand, and bore half the holes—each alternate one—then turn the rim over and drill the remainder; in this way the holes slant in the direction of the hub, and will appear somewhat zig-zag on the inside of the rim. Care must be taken, however, to place the spokes in the proper holes when building the wheel. Having drilled the rim, the next thing is to countersink the holes with a ¼-in. drill, at the same angle at which the rim was drilled; the countersinking should be just sufficient to let the spoke-head in flush.

In handling some of the light-made hollow rims, care must be taken not to dent them whilst centre-punching and drilling them. They should be struck very lightly with a good sharp centre-punch, and supported meanwhile on a block of wood cut to the shape of the rim and held in vice jaws.

To find the correct length for the spokes, which is an important matter, a full-sized diagram must be made similar to Fig. 133. Draw a line A B, and at right angles to it, at point C, mark off half the length of the hub—that is, from the centre of the hub to the spoke-holes—and then draw the half hub in section as shown. Measure the inside diameter of the rim, and sketch a section of the rim on the line A B at a point from C equal to half the diameter just measured. Next draw the line B E, which will be the length of the spokes, less the part that enters the flange, which should be not less than ⅛ in.

The spokes should all be cut to exactly the same length. The next step is to screw them, and the number of threads with which they must be cut will be regulated by the thread in the hub; leave about two or three extra threads at the bottom of the hole to work with in truing-up, else trouble will be experienced on account of the spokes "bottoming." If the hub is tapped to the depth of ½ in., the spokes should be screwed a little less—say $\frac{7}{16}$ in. Ascertain how many turns of the plate will be required to cut $\frac{7}{16}$ in., and give all the spokes the same number of turns. One of the most necessary things in wheel-making is to thoroughly "bed" the spokes—that is, to pass about $\frac{1}{16}$ in. of the unscrewed part of the spoke into the hub, or, if tangent wheels are being made, into the nipple. In order that this may be done, the holes in the hub flanges should be bored $\frac{1}{16}$ in. deeper than the spokes are screwed, so that when building the wheel the screwed part of the spokes will go out of sight into the flange. By this means the spokes will be a little less liable to break off level with the flange; when they do break off, it will be at the end of the screwing and a little within the level of the flange, thus providing a good recess for commencing to drill out the stump.

Unless provided with a spoke-screwing machine, a quick method of screwing the spokes will be to fix a small round screw-plate in a chuck in a lathe, and to hold the spoke in a spoke-grip or hand-vice, reversing the lathe to unscrew. If, however, the only screw-plate available is an ordinary long, many-holed one, the spokes must be held in the vice; when the lathe has a hollow spindle, the spoke may be held in the chuck and the screw-plate in the hand.

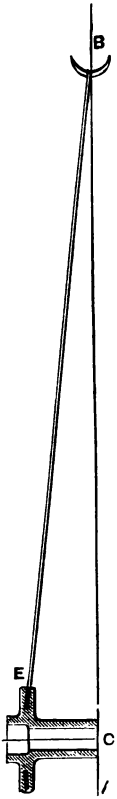
If the flanges of the hub are of unequal diameter, prepare the spokes for the smaller flange first; if these are spoiled in preparation, they can be used for the larger flange.

Before beginning to build the wheel, adjust the oil cup 'into position. Try a spoke in the hub, and screw it home; see that it is not too stiff to screw up, nor too easily screwed up; it should screw home with the aid of a spoke-grip without requiring much force, and it should not be so loose as to permit of being screwed home with the fingers without the use of a grip. Be sure that all the spoke-holes in the hub are properly cleaned out and tapped.

To put the wheel together, stand the hub on end on a bench or board, and support the rim on three or four pieces of wood, at such heights as will bring its centre level with the centre of the hub, which should stand at the centre of the rim. Pass the spokes for the uppermost flange of the hub through the rim, and screw them with the fingers only a little way into the flange holes. It will be understood, of course, that these spokes must be passed through each alternate hole. When all the spokes for one side have been put in, turn the work over and put the other spokes into the other flange holes. This done, screw up the whole of the spokes with a spoke grip till the screwed ends just disappear in the flange.

The spokes being all in position, something will be required upon which to true the wheel. Failing a truing-stand, a good makeshift will be one, or both, of the forks held in a vice or fitted and brazed to the head crown. Something really firm will thus be provided to true up the wheel, and assist in getting the hub central. Proceed to put tension on the spokes gradually, going round once or twice, and giving each spoke about one or two turns only;

do not be in too great a hurry to get the spokes home or the rim, instead of being circular, will



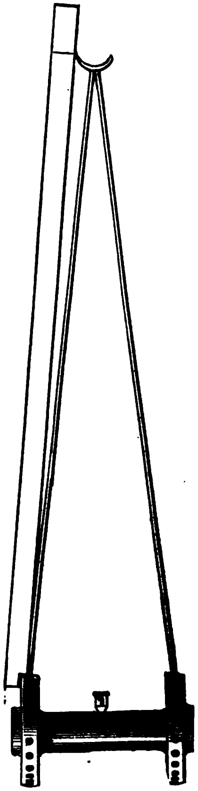


Fig. 133. Fig. 134. Fig. 135.

Fig. 133.—Method of ascertaining the Length of Spokes. Fig. 134.—Lath for truing Wheels. Fig. 135.—Method of truing Wheels.

have lumps and flats on it. After applying a little tension to each spoke, true the wheel by holding a piece of chalk rigidly against the forks so that it shall be grazed by the crest or trough of the rim groove when the wheel is spun round on its axle. Slacken the spokes on the chalked side and tighten those on the opposite side. Whilst this is being done, take care that the wheel does not become "dished"—that is, see that the rim does not get drawn bodily to one side. When finished, each spoke should have an equal tension, and there should be no threads showing above the flanges. Should one or two threads show above the flange, remove the spokes and replace them with fresh ones long enough to bed properly into the hub.

The centre line drawn round the rim for drilling the spoke holes must lie in the same plane as a similar centre line drawn round the hub midway between the flanges. There are various ways to test if a wheel is central in this respect. Stretch a piece of fine twine across the edges of the right side of the rim, and measure from the twine to the spoke-line on the flange; repeat the operation on the left side of the rim, and if the measurements are the same, the wheel is central. Or make a mark on the hub centre exactly midway between the flanges (the lubricating hole will do if drilled central), and stretch a piece of fine twine like a bowstring from the edge of the rim on one side of the wheel to the edge of the rim on the opposite side. If the twine touches the mark or hole on the hub centre, the wheel is true; if not, the wheel is more or less "dished."

A very good method of truing a wheel, is to make a notch in the end of a lath of wood, as in Fig. 134. This notch rests against the flange of the hub, as in Fig. 135. Make a mark with a pencil on the lath where the sharp outer edge of the rim touches it; apply the lath between the spokes all round the wheel on both sides, and observe where the edge of the rim falls within or without the pencil mark; this will show where to screw up and where to let down.

Be quite certain that all the spokes are drawn to the same tension; this can readily be ascertained by twanging them with the fingers. If they are all of c tension they will all give forth the same sound, bei all of the same length.

Having finished one wheel ready for the ty prepare the other wheel in exactly the same w Unless the hub and rim are of the same diameters before, it will be necessary to make a new drawing ascertain the length of the new spokes; or, if t same drawing is used, allowance must be made the difference in the size of the parts.

CHAPTER XI.

TYRES, AND METHODS OF FIXING THEM.

The construction of the wheels is almost the first job taken in hand by anyone building one machine only, because the wheels are required to build the frame and front forks to. The selection of rims and tyres has, therefore, to be attended to before actual work can be commenced, as certain kinds of tyres can only be used in connection with a particular kind of rim.

The Dunlop tyre, which requires a rim resembling in section that shown in Fig. 136, consists of two separate parts, an inner air tube and an outer cover. This air tube is made of indiarubber, slightly vulcanised on its outer surface. The Dunlop outer cover is made of a tough pliable cotton fabric, made tubular and formed into a ring the diameter of the wheel. Two hoops of steel wire are inside this tube, which is saturated with rubber which penetrates and fills the spaces between the threads of the fabric. The two wire hoops are pulled apart to lie parallel, and the rubber is then vulcanised, so that a band is formed with the hoops in each edge. These two hoops lie one on each side of the inner air-tube, around the outer surface of which the fabric is wrapped to form the tread of the wheel.

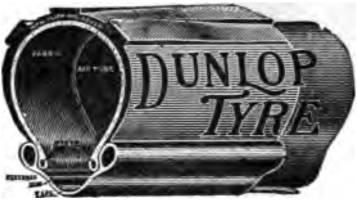


Fig. 136.—Section of Dunlop Tyre.

The Palmer detachable tyre is illustrated in section by Fig. 137. A single tube tyre, secured to the rim by cement, is also manufactured by Palmers. The latter consists of an indiarubber tube, around which two layers of fabric are wound spirally; each layer is embedded in rubber, and the two layers are separated from each other by a layer of rubber. The second layer of fabric is wound so that its threads are at an angle of 45° to the threads of the first layer. A protector and tread, encases the three inner layers, and completes the tyre.

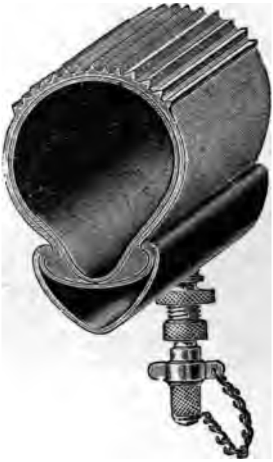


Fig. 137.—Section of Palmer Detachable Tyre.

The outer cover of the Palmer detachable tyre is made of fabric similar to that used in the manufacture of single tube tyres, but the fabric is laid on straight instead of being spirally wound. The edges of the cover are provided with a bead, which interlocks with the shoulders of the wheel rim, as shown in Fig. 137.

The Larue air-tight inner tube, a section of which is illustrated by Fig. 138, consists of a thin rubber tube, ide which, along the tread, is fixed a strip of chemic- ly prepared rubber. The composition by means of ich the rubber strip is secured to the rubber is soft d sticky, something like rubber solution, and if a ncture is sustained, the hole is filled up immediately on the withdrawal of the object that caused the ncture. The strip of rubber is stated to be always in tacky or semi-fluid condition. The inner tube is ncased in an outer tube. Tubes of this description re made in sizes to fit any kind of tyre.

The Clincher tyre, Fig. 139, has a moulded outer cover, a series of corrugations being provided in order to prevent sideslip. The outer cover is also furnished with lugs which fit into the shoulders of the rim and thus secure it and the tyre in position. A flexible canvas lining separates the outer cover from the inside tube; the object of this lining is to render the tyre soft and resilient, and, at the same time, puncture-proof. The inside tube does not stretch upon inflation, as it is made the same size as it will be when inflated.

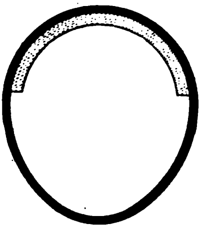


Fig. 138.—Larue Air-tight Inner Tube.

An air valve is necessary on all machines fitted with pneumatic tyres. Many different valves are in use, Woods valve, a section of which is illustrated by Fig. 140, is the one used in connection with the Dunlop tyre. In the illustration, A denotes the body of the valve, of which B is the head. The air-tube is pinched between plate C and the head B by means of a nut D.

Outside the rim the valve is secured by a milled n E. Plate C has lips F F, which fit in the bed of t rim and prevent the valve turning round. The a plug G is in one piece with the milled cap J. H denot a rubber tube which fits over the air-plug and preve the air escaping through the hole L. The dust-cap has a short length of chain for attachment to a spoke.

A section of the Smith corrugated rubber shie which can be fitted to the tread of any pneumatic ty is illustrated by Fig. 141. It is fixed in the followi manner :—The machine is turned upside down, and t tyres are inflated and afterwards cleaned and "roughe —that is to say, their surfaces are gone over with wire brush or a piece of glass paper. The under-si of the shield is also roughed with glass paper, af which the tyres and the shield are washed, or wip over, with naphtha. A thick coat of specially p pared solution is applied to each surface and allow to dry until tacky, the shield being then rolled up w the solutioned side outwards. One end of the shi is then cut perfectly straight, after which the shield applied to the tyre as the wheel is gradually revolve

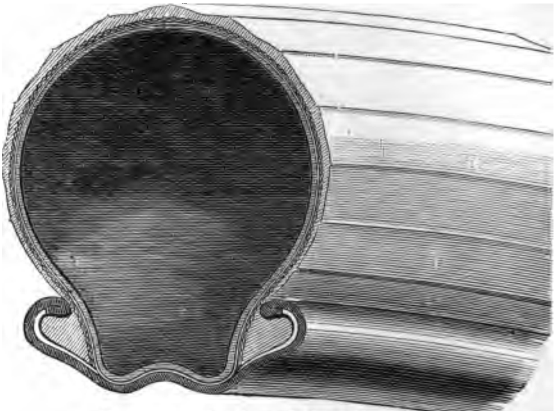
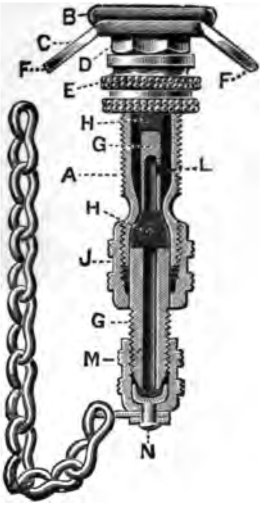


Fig. 139.—Section of the Clincher Tyre.

t for repairing cycle tyres can be made by unvulcanised indiarubber in coal-tar naphtha ide of carbon. Cement for securing tyres to ade by melting two parts of pitch and one percha in an iron pot. The ingredients in the se should be well stirred, and afterwards n a thin stream, into cold water. Having ly cleaned the rim, place the tyre on it with-



g. 140.—The Woods Valve, partly in Section.

cement, in order to see if it requires stretch- so, it must be pulled equally all round the lse there will be thick parts and thin parts, lumpy wheel.

the cement over a fire or a gas-jet, using an e with a spout to pour it from. Mount the a spindle caught in a vice or driven into a post, th a red-hot $\frac{5}{8}$-in. iron rod, heat up the rim all y revolving the wheel; this done, pour on the which, if properly melted, will be as thin as hot glue, and will run freely in an even stream all round the wheel, the ladle being held stationary and the wheel turned slowly with the left hand. Place the tyre in position before the cement is allowed to cool, and give it the necessary stretching, if any is needed, care being taken to place it in the rim without twist. There is generally a little ridge on the extreme top of the rubber tyre, left there in the process of moulding: this ridge forms a good guide for adjusting the tyre evenly in the rim.

A tyre-heater will be next required, preferably one in connection with which gas is used. The curved top of the heater is perforated, and emits a number of gas-jets, the gas being led up through the shank from a rubber tube attached to an ordinary gas-bracket with the

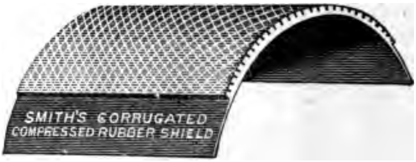


Fig. 141.—Section of the Smith Rubber Shield.

burner removed. These heaters are made with the jet-tube from 3 in. or 4 in. up to 9 in. or 10 in. long; 5 in. or 6 in. is quite long enough. A Bunsen burner may be used in the same manner, but will occupy more time. The rim is heated on the under-side, the rubber tyre being worked sideways with the fingers; the heater re-dissolves the cement in the rim, and, when that takes place, the tyre rolls freely and the cement oozes out at the edges of the rim. This is continued all round the wheel, about ten minutes being sufficient for the purpose. See that the rubber is without lumpiness when setting it in the re-dissolved cement, as any flat part can be easily curved by pressing the tyre from both sides towards it while the cement is hot. If too much cement has been put into the rim from the ladle, it will ooze out ch, smearing the rim and making the rubber tyre which it will not come off clean) very unsightly. should only be as much cement in the rim as will he rubber float when it is re-heated. If the rims ones, melt the cement already in them with a hot put some new cement in if necessary; then put ber in place, and re-heat as described above. he tyres have been set in the rims and put aside hour or two, all superfluous cement must be l off.

Fleuss tyre differs from those already mentioned ng no inner air-tube. It is attached to the wheel a similar way to that shown in Fig. 137. This like the outer case of that shown at Fig. 136, and be partially detached from the rim so as to get inner surface. In case of puncture this tyre is d by putting a patch on its inner side, and the ssure, when the tyre is inflated, seals the hole.

CHAPTER XII.

ENAMELLING.

ALL good cycle work is stove-enamelled. To the mechanic who makes his own machine the fitting up or provision of a proper enamelling stove will, in most cases, be out of the question. It will, however, be possible to provide a substitute by making a box-shaped framework of 1 in. angle-iron, and riveting sheet-iron of about 18 B.W.G. to this to make an oven.

A door, which should be hung on stout iron hinges, should occupy the whole of the front; the framework for the door can be made of 1 in. by ¼ in. iron, plates of iron being riveted to it. A slit, about 1 in. by 6 in., covered with sheet mica, should be cut in the door, for reading the thermometer, which should be hung inside, and must register higher than the highest temperature the stove is capable of reaching; if the thermometer only registered 400°, it would burst if the stove ran up to, say, 500°.

The enamel had better be purchased ready-made, as any attempt to make it is almost certain to end in disappointment. The ordinary Japan recipes are not suitable for the purpose. It is a good plan to obtain the enamels a shade or two lighter than required, allowing the stoving to tone them down. Keep the enamel well mixed by thoroughly stirring it every time it is used, or the colour is liable to sink to the bottom and produce streaky work.

Fix the stove in a place most free from dust and dirt, and away from any door or window leading into the open. As one of the secrets of successful enamelling is cleanliness, be careful to have the enamel free from dust and grit, and keep it so by straining it occasionally through fine muslin or flannel

Gas is now generally employed for heating an enamelling stove, and an ample supply is necessary. Pipes of 1¼ in. internal diameter will be required from the meter to the stove. If the stove is a small one—about 6 ft.×6 ft.×3 ft. 6 in.—six rows of atmospheric burners will be required inside to heat it. These can be made from six pieces of 1¼-in. gas tube 3 ft. 6 in. long, stopping one end of each and drilling ⅛-in. holes about 1 in. apart, the other end being left open for the insertion of ordinary ⅜-in. brass gas taps ; or perhaps three rows of burners the length of the stove will be preferable, and suit the position of stove and shop better. However arranged, sufficient heat to provide a temperature of 400° Fahr. will be required.

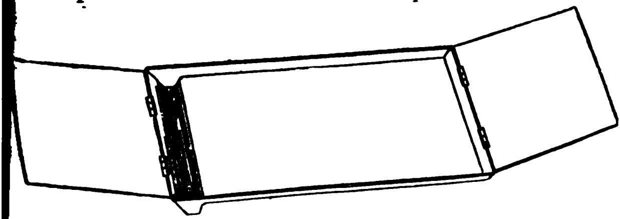


Fig. 142.—Enamelling Pan.

Rows of iron rods must be fixed inside the stove, about 3 in. or 4 in. from the roof, to hang the work from, or several angle-iron ledges may be used, on which the rods or bars can be fixed. A pan, Fig. 142, which may be made by any tinman, will be found most economical to use, for with it a single cycle may be completed with as little as one gallon of enamel. The side flaps should be hinged in order that the pan may be covered up when not in use.

The work must be thoroughly cleaned and freed from grease. The better the surface is got up by emery cloth, etc., the better will be the finish of the enamel. Hang the work on hooks immediately over the pan, and ladle the enamel on with an ordinary iron ladle. Allow it to thoroughly drain off, then hang the parts in the stove, particular care being taken that no tube or part is in such a position that it has not sufficient slant to allow the enamel to run off. Front forks, for instance, should be hung with the crown uppermost when stoving for the last time. When closing the door, do so carefully or the lights will go out.

If a large quantity of work is being done it will be economical to use a cheap enamel for the first coat; but, if only two or three machines are likely to be done it will scarcely be worth while to purchase two kinds, as two coats of one kind will be sufficient. The first coat, when hard and cold, is rubbed smooth with tripoli powder and fine pumice and afterwards hand polished with rotten-stone or putty powder and another coat applied and baked as before. The enamel must be kept sufficiently liquid to run off the work freely. When it gets too thick, thin it down with a little paraffin oil.

In re-stoving old machines, remove the tyres from the wheels; also the horn handles, and take out the balls and cones. If there is any soft solder about the machine—such as at the crossings of laced spokes and mud-guard bridges—put the work in the stove at a temperature of about 270°, and let it remain n longer.

The temperature and length of time necessary to finish the work properly will depend on the make of the enamel. Wheels require an enamel to stove at a lower heat than the other parts of the machine.

To fix transfers to cycles, properly and permanently, a stove is required; they may be fairly well fixed without, but will not, of course, wear so well nor look quite the same. A slab of slate, stone, marble, or even a smooth piece of wood, is required to work the varnish or gold size on, as it cannot be applied too thinly so long as the transfer is completely covered with the varnish. Any good, clear, quick-drying varnish will do, and the drying qualities of the varnish l regulate the time necessary to allow between lying it to the transfer and putting the transfer the machine. Besides varnish, a small camel-hair sh, a small sponge, a piece of soft cloth, flannel, or hleather and water, are all that are required.

Cut the transfer from the sheet, lay it face upwards the slab, and apply varnish evenly and very thinly r it, care being taken that the whole of the gold d colour, if any, is covered. Do not rub the varnish over the paper, but simply cover the printed matter ; will look all the neater when on, especially if the rk is not to be stoved.

When the transfer is varnished, let it stand till good dry tack is arrived at. About ten minutes ould suffice with a good quick varnish, but transfers re sometimes allowed to stand fifteen to twenty inutes, and then they come off well. Wipe the part f the frame where the transfer is to go, and lay it n evenly, pressing down the centre part first with he thumb, and working outwards at each side in rder to obliterate air bubbles which are very apt to collect. When evenly adjusted, press the transfer well down all over, taking care not to shift it in so doing. The warmth of the hand helps the gold to leave the paper. Rub it well all over with a soft cloth, then damp the surface with a wet sponge ; warm water is better than cold. Press it again all over, and be careful not to disturb the gold. Wet the surface again, more freely than before, and immediately peel off the paper, when the transfer should be left perfect in every line.

Do not touch it at this stage or attempt to varnish it, or the gold will be disturbed. It should now be hung straight, for about ten or fifteen minutes, in the stove at a temperature from about 150° to 200° ; if any colours are used, lower heat will be best. After taking it from the stove, and when it is nearly cool, varnish it neatly and stove it again at the same temperature, and for the same length of time, or even longer—

say twenty minutes, if the heat is not too great, i which case the gold and colours would blister an the gold turn brown.

The *final* varnishing should be floated on prett freely, and not, as in the first instance, very sparingl —that is, if the work is to be stoved.

A curved surface, such as that of mud-guard where the curvature is in two directions, will be mor difficult to deal with than a straight tube or flat surface and will require more careful pressing down before and after the first damping.

When no stove is at hand, the varnish used should be of a quick drying quality and should be put on sparingly in both instances. After the transfer is fixed, allow it to stand half an hour, or even more, before varnishing finally and then, again, even longer before handling the work.

Warmth is conducive to good work ; it helps the gold to leave the paper better. The operation should be done in a warm room, or, preferably, in an enamelling-shop when the stove is being used ; the latter, however, is not absolutely necessary. The transfers should also be kept in a warm dry place.

The fine gilt and other lining on bicycles is usually done with small flat brushes called lining tools, but is also done with a long sable pencil with rather a stumpy handle. When the brush gets clogged at the ferrule, dip it in turps, but do not overdo this, or the paint will be apt to crack off. The gold-leaf is laid on a surface of gold size which has become tacky by exposure for a few minutes to the air.

CHAPTER XIII.

REPAIRING.

Repairing Pneumatic Tyres.—The outfit necessary for repairing pneumatic tyres consists of thin sheet indiarubber, rubber solution (which is a mixture of naphtha and indiarubber), fine sandpaper, and powdered French chalk. These materials can be bought at any cycle accessory dealer's warehouse. As double-tube pneumatic tyres are similar in principle, the same instructions as to repairing will apply to all, the difference between the various patterns being the methods of detaching from the rim. First examine the defective tyre, and if a thorn, tack, or other sharp substance is found sticking out of the cover, pull it out and mark the spot carefully. When the cause of the escape of air cannot be traced to this source, examine the valve, and see that the valve tube properly covers the orifice in the stem. If this tube is found to be split, or is not long enough, it should be removed and replaced by a new one, care being taken that it is drawn up over the small cone at the lower end of the valve stem. If, after this has been done, leakage still occurs, the tyre must be detached and the inner tube tested. Take off the valve by unscrewing the nuts on the inner side of the rim; then the outer case must either be taken off or loosened sufficiently to allow the inner tube to be drawn out. Readjust the valve on the tube, and inflate the tube slightly. If the leakage is large, the source will be quickly discovered; but if only slight, it may not be so apparent. Dip the inflated tyre into water, a little at a time, and the location of the puncture will be evident when bubbles of air are seen to issue from the tube. With a piece of glasspaper remove the white substance from round the puncture, then cut a piece of the sheet rubber just large enough to lap beyond the edges of the orifice; clean this with glasspaper, chamfer the edges a little, and rub the solution over the surface and the chamfered edges. Coat the inner tube with the solution over about the same area as the patch, and let the two remain fully exposed to the air for about ten minutes; then place the patch over the hole and press it well down. After allowing time for the uniting of the surfaces, powder a little French chalk round about the place, and the tube will be ready for re-insertion. If the tyre has burst, and a piece of the outer case has been blown out, a new piece must be let in and recanvassed on the inside of the case.

Solid Tyres.—For repairing cut solid tyres there is nothing better than the best and purest rubber dissolved in bisulphide of carbon, chloroform, oil of turpentine, or naphtha; or pure rubber may be cut up fine and dissolved in benzine or other rubber solvent. Clean the cut parts, and smear them with the solution; keep them open for an hour or so, after which they may be pressed close, and the tyre will be ready for use.

Fitting New Rims to Cycle Wheels.—The fitting of new rims to cycle wheels is a job which sometimes requires to be done, either in order to replace broken rims or to adapt the wheels to tyres of a different section to those used formerly. Remove the wheel from the frame and the tyre from the rim; if the tyre is cemented to the rim it can generally be pulled off without the application of heat, but care must be taken not to tear it if it has been well fixed with good cement. Loosen the tyre in the rim by pressing with the thumbs on each side alternately all round; if it then shows a tendency to tear, it will be well to heat the rim with a gas-burner, blowpipe, or spirit lamp, taking care not to burn the tyre; if the same tyre is to be used again, this will probably be the quicker and more economical method.

Before proceeding to take the old wheel to pieces, mark off the new rim for drilling the spoke holes—that

if they are not already drilled. Place the new rim
ly on the old wheel, and tie it tightly in three
four places; hold the wheel and rim in a vice by
spindle or spindle nut, using brass or lead to pre-
t the vice marking the work. With a piece of slate
cil or stick of chalk mark off accurately in the
llow of the new rim the position of the spokes cor-
ponding with those in the old wheel. Untie the rim,
ribe a line all round down the centre of the rim with
pair of odd-legs, compasses, or a scribing block made
ith a pointed wire nail driven through a block of
ood, and then centre-punch for drilling the holes
in. each side of the line alternately, so that half the
poke holes will be on one side of the line and half on
e other side. Hold the rim over the vice jaws or on a
ece of iron, and if a solid rim punch it deeply. Should
be a hollow rim, great care is necessary in centre-
nching, or the under section will get dented and
maged. To avoid this, cut a piece of wood about
in. long to the shape of the under section, fix this
the vice, and centre-punch it lightly. Take the old
wheel to pieces by unscrewing each spoke with a spoke
grip, or, if the spokes are tangent spokes, by unscrew-
ng each spoke nipple with a nipple key. It will not
e necessary to remove the spokes from the hub if they
re tangent spokes, unless the new rim is larger in
diameter than the old one ; then, of course, new spokes
will be necessary. But this will only occur when replacing a hollow rim with a solid, or a cushion with
a solid-tyred rim.

Should the old wheel have been frequently repaired with new spokes and by inexperienced hands, there will probably be several spokes of stouter gauge than the rest, and those even of unequal gauge in the threads. In that case it will save time when putting together later to mark the hub flange and odd-sized spokes before taking the wheel to pieces, so that they may be readily replaced in the hub. When the spokes are all removed from the rim and the hub, tie them up together. If more than one similar job is being done at the same time, it will be well to label each one, so that there may be no possibility of getting them mixed.

Should the wheel have tangent spokes, and the new rim be of such a section as to require longer ones, then the spokes must be stripped entirely from the hub. A well-made tangent wheel will have its spokes bound with wire and soldered at the outer crossing, so cut the wire binding and unsolder the connections. Before taking a tangent wheel to pieces, notice how the spokes are crossed — that is to say, how many holes apart in the rim each pair of spokes is brought up to. Should the rim be of hollow section, there will probably be a small metal washer under the head of each spoke nipple. If so, care should be taken in removing the nipples, or the washers may be left in the rim and difficulty will be experienced in recovering them again. Screw a piece of spoke wire to fit the nipple, and when the nipple is unscrewed from the spoke, insert this wire into the nipple for a thread or two, and do not remove it till both the nipple and the washer are safely out of the rim.

The holes in the rim should be drilled aslant, so that they point direct to the hole in the hub into which the spokes are to go. If the rim is to be drilled horizontally on an ordinary turning or drilling lathe, the best way will be to pack the lathe bed with a piece of wood of a thickness that will raise the centre of the wheel to a distance from the height of the centres equal to the width of the hub flanges. For instance, supposing the lathe has 4½-in. centres and the hub flanges are 2¼ in. wide, then the *centre* of the rim should be just 2¼ in. from the face of the lathe bed. With the rim thus supported, drill every alternate hole, then turn it over and drill the other half. This will give the necessary angle to ensure the spokes and nipples having a straight pull from rim to hub. If the rim is a stout gauge solid or cushion rim, it will be well to ntersink the holes slightly in order that the heads f the spokes may lie snug. This should only be done the spoke heads are of such a shape as require untersinking; now that light gauge rims are in use, poke heads are made flatter, and require no counter-nking. If nipples are used with solid or cushion ims, the holes in the rims should be countersunk. The ountersinking should be done alternately and at the ame angle as the holes are drilled.

Hollow rims should be drilled in the same manner, ut with a twist drill and at a high speed. If a flat rill is used at a low speed, the holes will be jagged nd irregular in shape. Drill right through the two ections first with a small sized drill, and open out the top section for the washers afterwards.

In the case of wooden rims, the nipples should *fit* the holes in the rims perfectly and without shake, and the holes should be drilled so that the nipple points *exactly* to the part of the hub to which the spoke will run. The extra thickness of the material surrounding the nipple and the tightness with which it fits in the rim will not allow the spoke to pull the nipple straight if the angle is slightly askew, as would a light gauge steel rim with a slacker fitting nipple. Unless the nipple fits the wooden rim tightly, water will be likely to get in round the nipple and cause the rim to warp or crack. Wooden rims *must* be built up with washers and countersunk to the shape of the washer, but they should not be countersunk any deeper than is absolutely necessary, or the rim will be weakened. For nipples those having long round shanks of smal diameter are preferable. A twist drill with a goo clearance cutting edge should be used, run at a hi speed and kept very sharp; otherwise a lot of bur which is troublesome to remove, will be thrown up the under-side of the rim.

The new rim having been drilled, proceed to put wheel together. If the rim is of exactly the diameter as the old one, no difficulty will be exper as the same spokes, without alteration, can be used. Screw in four spokes, equidistant from one another, on each side of the hub. If direct spokes are used, they should screw in to the end of the thread without distorting the rim; this will allow the spokes to bed in the hub about two or three threads when all the spokes are in and the wheel is properly tensioned. If the new rim is of different diameter from the old one, find, by the following means, the exact length of the spokes required: Place the rim on a bench with the hub exactly in the centre, and in such a position that the centre of the rim is in the same plane as the centre of the hub. With a thin lath or spoke measure the length of the spokes required, allowing for about ten or twelve threads to be embedded in the hub flange and for the thickness of the rim. Cut off eight spokes and screw them, then insert them in the rim and the hub, and screw them up till the last thread can only just be seen above the hub flange. The rim should then run fairly true, without any shake or play. If this is satisfactory, remove one spoke, mark it as a pattern, and cut off and screw the remainder of the spokes.

A tangent wheel is treated in a somewhat similar manner, only the spoke length must be measured at a tangent from the particular holes in the hub flange and the rim from and to which the spoke will go, and not straight across as in a direct wheel. When the approximate length has been obtained, cut off eight spokes, screw them, and place them in the rim at the proper tangent—two pairs on each side of the rim—and screw up as before. If satisfactory in length, remove one and cut off the remainder to the same length, then screw them and place them in the rim. The outside spokes running to the right should pass under those running to the left, or *vice versâ*, at their outer crossing.

The truing of the wheel will require considerable skill and patience. The chief points to arrive at are equality of tension in all the spokes, truth of circumference in the rim, and concentricity in the hub and rim. Insert all the spokes in the wheel, and screw them up equally, but not far, so that there is no shake or looseness in any of them, and yet no actual tension; place the wheel in the forks, and proceed to true up. The advantage of having cut every spoke to exactly the same length and screwed it with the same number of threads will now be apparent, for having done this, and proceeded as above, the wheel will admit of being made fairly true by giving each spoke or nipple just one turn and no more; then spin the wheel round, and if the rim is approximately true sideways, hold a piece of chalk to its top, and to the spokes that are marked by the chalk as the wheel revolves give a turn or two. If, however, there is now a fair amount of tension on the spokes, and in one or more parts there is a flat or hollow in the circumference, let out a few spokes where the flats or hollows appear *before* taking up where the chalk marks appear. In this manner get the wheel true in circumference, at the same time watching that it is kept fairly true sideways. When it is true in circumference, proceed to get it true between the forks thus: Spin the wheel, hold the chalk to the edge of the rim on the side, let out the spokes on the same side of the rim as the chalk marks, and take up on the opposite side; if there is already a fair amount of tension on the spokes, a half- or quarter-turn to each of the spokes moved will be ample. By proceeding carefully in this manner the wheel will gradually be got true. Whilst these operations are going on, keep as far as possible an equal tension on all the spokes, as upon this depends in a great measure the ultimate life and stability of the wheel.

Another thing to avoid is getting the wheel "dished" —that is to say, pulling the rim more over to one side of the hub than the other. This may be done and yet the wheel may be perfectly central in the forks, owing to the forks being of unequal length. To test if the wheel is at all dished, take a piece of twine and stretch it across the wheel from edge to edge, and so that the twine nearly touches the centre of the hub by the oil hole. If the oil hole is drilled centrally between the flanges, and if the twine comes exactly over the centre of the hole, the wheel is not dished; but if the hole is central, and the twine comes more to one side than the other, then the wheel is dished, and *all* the spokes must be let out on the dished side, and taken up on the opposite side. Give each spoke an equal part of a turn, provided the wheel was true at the start, and that it had the required amount of tension. If the wheel, however, is rather slack—that is to say, if the spokes are low in tension—it will probably be possible to do two operations at the same time—namely, to take out the dish and bring up the tension—by taking up only and omitting the letting out, which will bring the rim over and tighten the wheel.

If it is a tangent wheel, the spokes should now be tied and soldered. At the outer crossing make two neat turns with fine copper wire, cross the ends, and turn them with pliers till they break off. Solder the joint with a copper bit or with a very small Bunsen burner flame. If a flame is used, care must be taken not to get the spokes too hot, as this would cause them to stretch and thus let down the tension of the wheel. If the rim used is a solid or wooden one, examine each spoke inside the rim, and if any of them project beyond the nipples, smooth them off with a file. After soldering, carefully wipe all traces of the soldering fluid from the work, and it is ready for enamelling.

Wooden rims should on no account be stoved either in order to blacken the spokes or to fix the tyres; but he wood should be given one or two coats of good hard-drying varnish, which, worked well in round the spoke n nipple holes, will help to keep out the wet.

Drilling out Broken Spokes.—When drilling out a broken spoke from the hub, it is a great advantage to get the broken piece out without enlarging the threaded spoke-hole. Use a centre-punch which has a fine point to lightly punch the centre of the broken piece. Select a drill at least one gauge smaller than the spoke, and at first drill cautiously and frequently remove the drill to see that it has started centrally: If not, draw the centre mark over, by means of the punch, to the required position, and start drilling again. Left-handed drills should be used for this purpose, and they should be rotated in the direction of unscrewing. It frequently happens that, during the process of drilling the broken piece when it has been drilled some distance, the drill catches the broken stump and winds it out without damaging the thread of the hole; and unless the drill is rotated in the right direction this would be impossible. Drill to the bottom if the piece does not come out before.

Spoke-Holes too Large.—In removing old spokes and replacing them with new ones, it not infrequently happens that the threaded spoke-holes in the hub flanges become damaged or enlarged. To restore a spoke-hole to its proper size, drive a piece of brass wire tightly into the enlarged hole, and drill a new hole of the tapping size down the centre of the wire, or a butted spoke may be fitted in the enlarged hole; the spoke should be of equal gauge to the other spokes in the wheel. In such a case the butt should be cut short so that the thickened portion does not appear above the flange of the wheel.

Stopping Rattle in a Safety Frame.—To stop the rattle of loose spelter in a cycle frame, ascertain the tube in which the noise occurs, drill a small hole in it, out of sight, and insert some powdered tyre cement. Shake the cement and the spelter down to the lowest part of the tube and heat gently with a spirit lamp or gas flame until the cement melts; the cement, on cooling, will secure the spelter to the tube. Stand the frame to cool in the position the machine will assume when mounted on the wheels. When heating the tube to melt the cement, move it about in the frame and no damage will be done to the enamel.

Fitting New Forks.—Should it at any time become necessary to fit new forks to a machine, assuming that the crown is a double-plate one, as Fig. 45, the best method of doing the work will be as follows:—Unbraze and remove the old forks, one at a time; drill the ends of the new blades for the wheel-spindle, and cut the blades off to the required length, care being taken that both are exactly alike. Fit the blades to the plates, fix the front wheel spindle and cones in place in the fork-ends, and screw the nuts on tight. Braze on one blade at a time, with the fork lying on one side. If the tops of the blades are to have caps to fill up the ends, the caps must, of course, be fitted before brazing. A small air-hole should be drilled inside each blade, near the bottom, or the caps will blow out when the brazing is being done.

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